

# Compressed Air

## Magazine



### RACE TRACK FOR ATOMS

Brookhaven's Giant Proton Synchrotron Will Aid Nuclear Studies

JANUARY 1959

739-A-21  
B-55

UNIVERSITY MICROFILMS  
313 N. 1st St.  
Ann Arbor, Mich.



## 225,000 cu yd of Sandstone Gets the "Old Heave-ho" at Sutton Dam

Boring most of the blast holes with Bethlehem Hollow Drill Steel, they recently moved 225,000 cu yd of abrasive sandstone at the site of Sutton Dam, Sutton, W. Va. The Bethlehem Hollow, fitted with both multi-use and carbide-insert bits, put in holes up to 15 ft deep.

Sutton Dam is being built under the direction of the U. S. Army Corps of Engineers, Huntington District. Primarily a flood control dam, it will also regulate the flow in the Elk River, for Charleston's water supply system. Upon completion in 1959, the concrete gravity structure will be 1178 ft long, and 250 ft high.

### Bethlehem Hollow is Economical

You can take on any kind of rock and drill it economically with Bethlehem Hollow. It's rolled from a grade of steel that's outstanding for its fatigue resistance. The center hole is true and smooth. And with its wide quenching range, it's easy to heat-treat for the proper balance of toughness and wear-resistance. You'll get both durable threads and shanks.

Bethlehem Hollow comes in Carbon and Ultra-Alloy grades in rounds, hexagons, and quarter-octagons, and is regularly furnished in standard lengths of from 18 to 27 ft. Longer lengths can also be supplied. Be sure to specify Bethlehem Hollow for your next rock removal project.

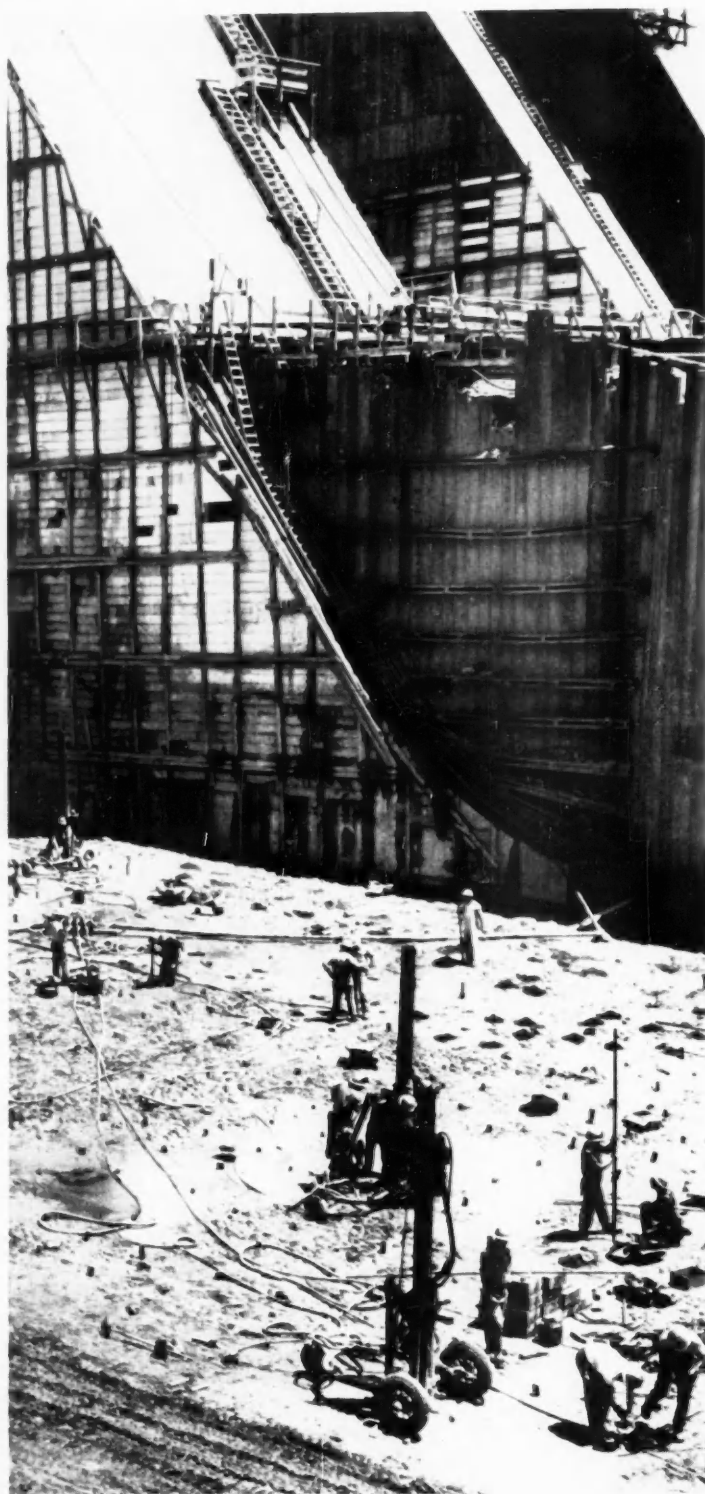
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Bethlehem Hollow Drill Steel bores blast holes up to 15 ft deep at site of Sutton Dam on Elk River at Sutton, W. Va. Contractors: Arundel-Dixon-Hunkin Joint Venture—The Arundel Corp., The Hunkin-Conkey Construction Co., and L. E. Dixon Co.

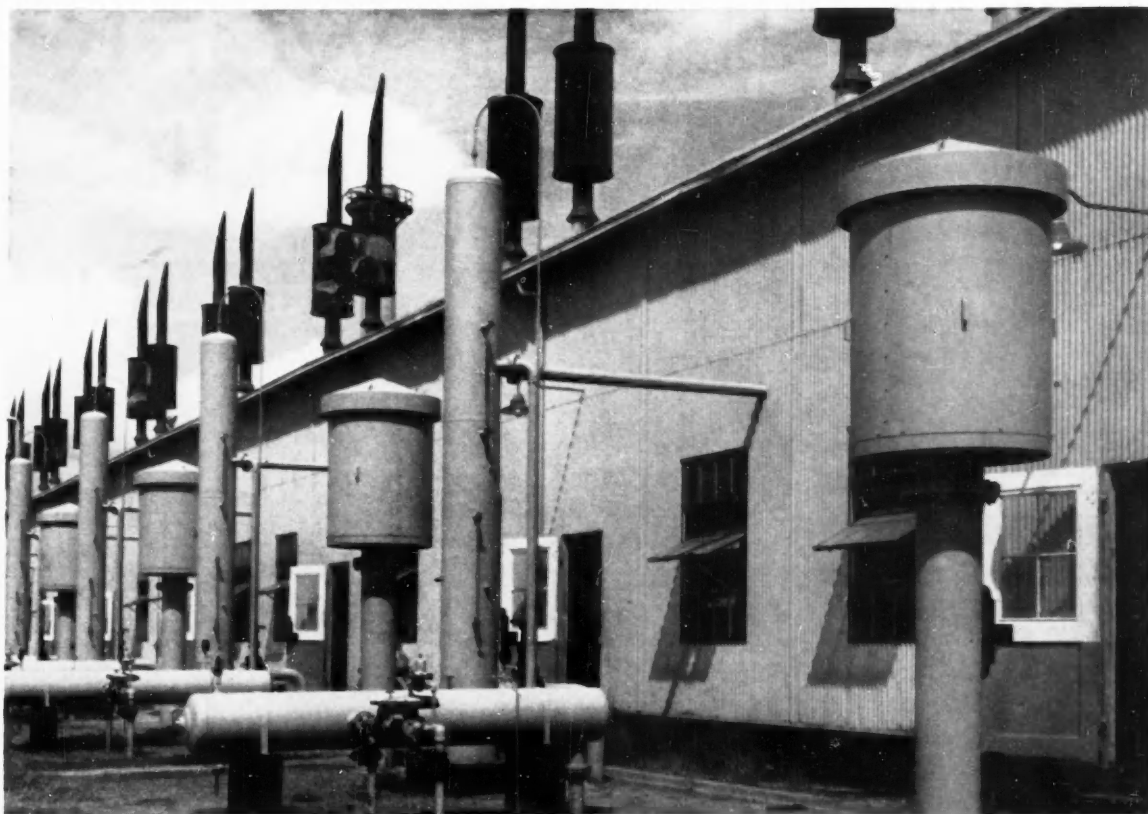
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**BETHLEHEM  
STEEL**





Partial view of a Falfurrias, Tex., gas plant showing four of eight Staynew air-intake filters that are effecting spectacular economies in maintenance costs for La Gloria Oil and Gas Co.

## Filters Function Four Full Years Without Maintenance

In 1952 the Falfurrias, Tex., gas plant of La Gloria Oil and Gas Co. substituted two Staynew air-intake filters for conventional oil-bath filters on two gas-engine-driven, natural-gas compressors.

Two and a half years later the pressure drop through the Staynew filters had increased only to where it equalled the pressure drop of an oil-bath filter *immediately after an oil change*.

Air resistance was not yet enough to warrant cleaning. Therefore, La Gloria left the filters alone for another 19 months before deciding on an overhaul.

Oil-bath filters by comparison had required an oil change every 10 months, each change calling for 60 gallons of oil and high labor costs.

As evidence of its satisfaction with Staynew filters, the company installed four more in 1954, another pair in 1955, and an additional three in 1956 to replace the last of the oil-bath filters.

The efficiency of Dollinger Staynew filters actually increases with use. So why buy filters that require rigid maintenance schedules? Let a Dollinger representative show you how to save time and money with Staynew Intake Filters, or write for Bulletin 100. Dollinger Corporation, 7 Centre Park, Rochester 3, N. Y.

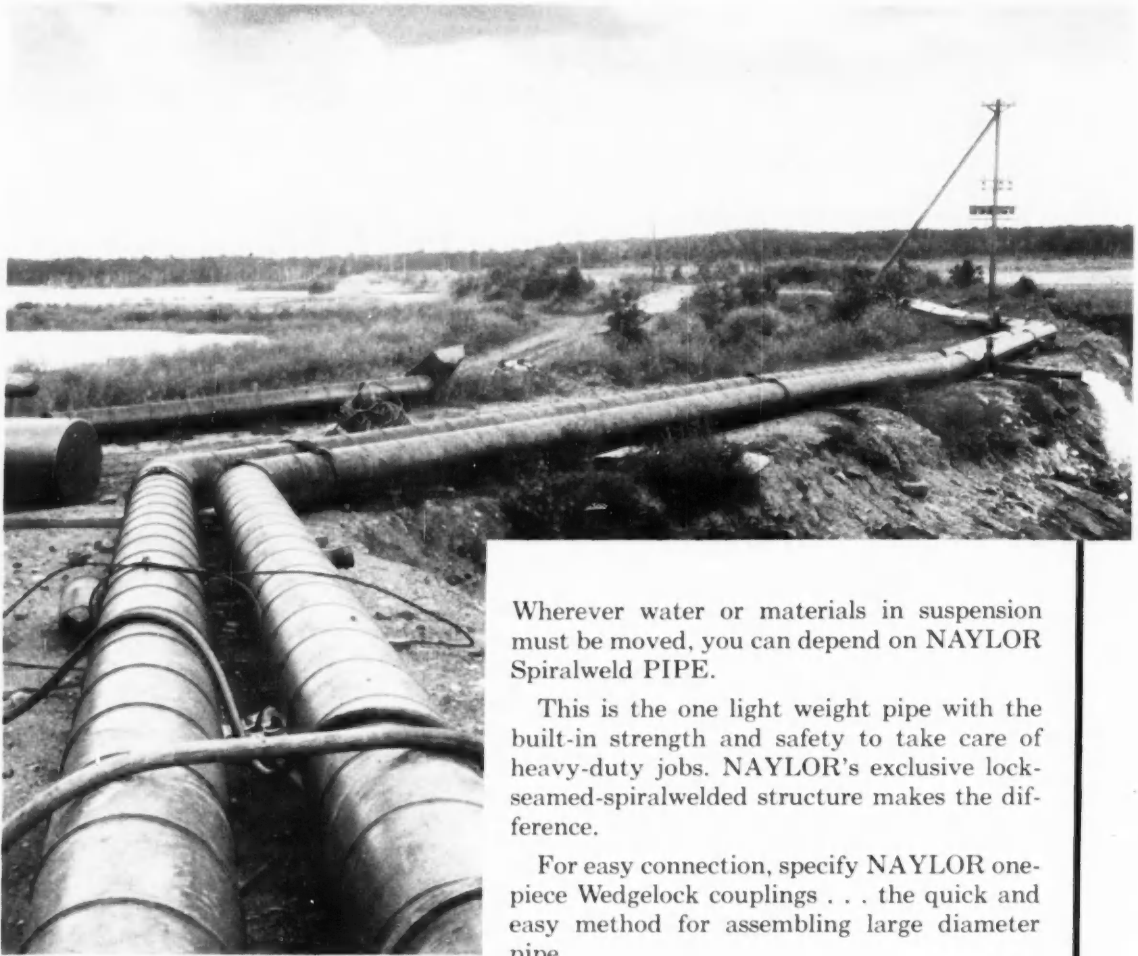


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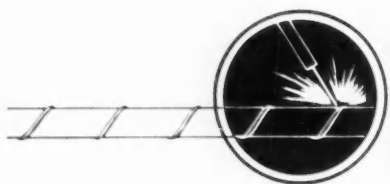


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This is the one light weight pipe with the built-in strength and safety to take care of heavy-duty jobs. NAYLOR's exclusive lock-seamed-spiralwelded structure makes the difference.

For easy connection, specify NAYLOR one-piece Wedgelock couplings . . . the quick and easy method for assembling large diameter pipe.

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# Compressed Air Magazine

Founded 1896

VOLUME 64 NUMBER 1

January 1959

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## ON THE COVER

THE VIEW on this month's cover is Brookhaven National Laboratory's giant new proton synchrotron—world's largest and most powerful machine for study of the atom. The 840-foot diameter circular structure houses the magnets for the 25- to 30-billion electron volt accelerator. On the right, astride the tunnel, is the target building. On page 26 is shown a cross-sectional view of the tunnel during construction. The device is expected to be ready for use this year and will cost an estimated \$25 million.

## FEATURE ARTICLES

### Page 10 New Power Scheme At Niagara—R. J. Nemmers

The Niagara River packs more power in its short 36-mile length than most rivers many times its size. That power is more highly developed than elsewhere, or will be when current work is completed. The salient features of the project are listed and the description includes some data about line-hole drill rigs developed for the job.

### 17 Better Service To The Customer

Good customer service, to a utility, means more than insuring adequate supplies of the given commodity. It also requires prompt attention to requests for service and to discontinuities that might occur. Air power helps one gas company meet these needs.

### 20 Union Dome—Peter Sleight

The principles of the geodesic dome have been applied to a remarkable repair and service structure owned by Union Tank Car Company. Located near Baton Rouge, La., the building reflects a new concept of rail car maintenance practice. The design provides for faster more efficient flow of cars and material through the various reconditioning steps than previous shop structures.

### 25 Air Isolation Protects Fragile Missile Parts

One of the most common uses of compressed air is for cushioning shocks. It's now been put to work soaking up the grueling impacts of modern day missile firings.

### 28 X-15 Rocket To Carry Own Atmosphere

When man finally jumps into space, he will have to take along his own atmosphere to survive. A preview of this will be in operation when the X-15 rocket reaches out to the fringes of space.

### 28 3-D Model Kit Helps Design Machine Tools

The do-it-yourself fad has spread to industry. In the case at hand, it involves the use of 3-dimensional models of machine tool components to aid designers.

## DEPARTMENTS

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MORE ABOUT THE GARLOCK 2,000



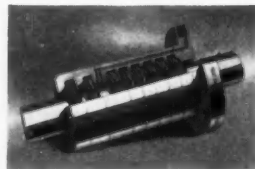
## NEW "MIRROR-FINISH" ON GARLOCK METAL PACKINGS

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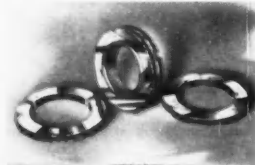
Now all Garlock Metal Scraper and Packing Rings have a surface finish of 10 micro-inches or less! And flatness of the rings is measurable in light bands; which means a more positive seal between ring and groove. This exclusive Garlock advantage has been made possible through improved manufacturing technique and is offered to you without additional cost.

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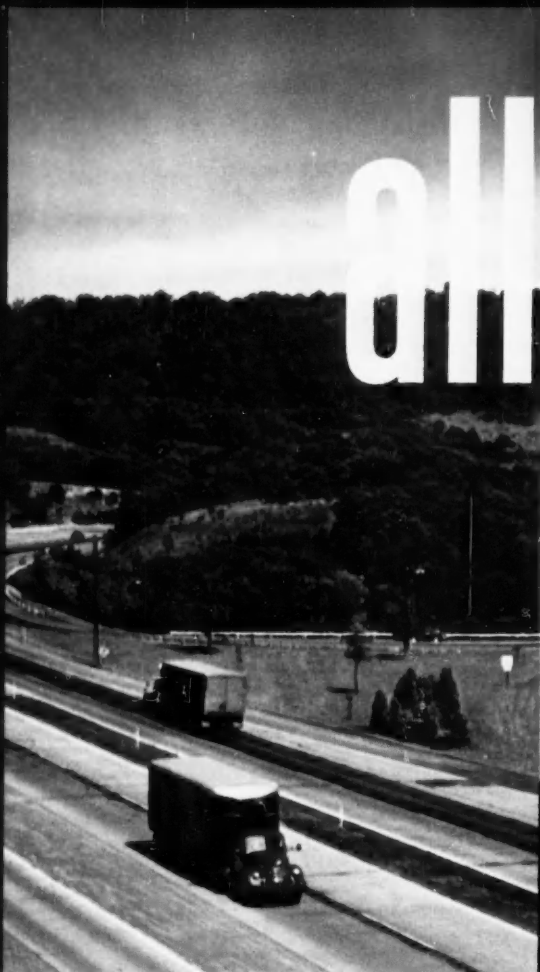
**GM  
DIESEL**

A whole new  
concept  
in power

**all purpose power line**

(20 to 1650 H.P. IN ONLY 3 CYLINDER SIZES — "V" AND "IN-LINE")

# all purpose



## GM Diesel combines 8 New Basic "V" and "in-line" engines with it

**T**o help industry fill its power needs, GM Diesel engineers have developed the most comprehensive power concept since they pioneered the small 2-cycle Diesel.

Using only 3 cylinder sizes, they have more than doubled the number of basic engines—vastly increased the horsepower range—yet maintained the family relationship and parts interchangeability for which GM Diesels are famous.

*Each engine features the ultimate in compactness, light weight, high efficiency, durability and inexpensive maintenance.*

Basing their design on that of the versatile and capable GM Series 71 Diesel, GM Diesel engineers have created 8 new basic "V" and "in-line" engines which will add vastly new power coverage to the present Series 71 and 110.

First, the new Series 53 Diesel—comprising four basic "V" and "in-line" engines—is a smaller, more compact version of the famous "71."

Here, at last, in the Series 53, are Diesels which cover the lower horsepower ranges as never before. They hurdle the barriers which have limited the use of Diesel power in a whole host of applications. They offer new opportunities for Diesel power to farmers, boatowners and industrial users by making available GM Diesels particularly suited to their needs. They will pay for themselves amazingly fast when they take over from gasoline engines.

Four new "V-71" engines complete the additions—widen the power range of the "in-line" 71 Series—set new standards for low weight and small size per horsepower. These "V-71"

The GM Diesel  
All-Purpose  
Power Line  
20 to 1050 H.P.  
in only 3 cylinder sizes  
NON-TURBOCHARGED RATINGS



**NEW**

"2-53"  
20 to 67 H.P.



"3-71"  
33 to 67 H.P.



**NEW**

"4-53"  
36 to 97 H.P.

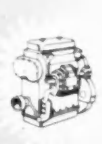


"6-71"  
51 to 118 H.P.



**NEW**

"8-53"  
51 to 130 H.P.



"10-71"  
69 to 167 H.P.



**NEW**

"12-53"  
76 to 195 H.P.



"16-71"  
112 to 252 H.P.



"20-71"  
112 to 252 H.P.



# e power line

(20 to 1650 H.P. in only 3 Cylinder Sizes)

## s with its proved "Jimmy" Diesels

basic "V"

er the lower  
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ey will pay  
over from

—widen the  
standards for  
ese "V-71"

engines bring far more power than ever before possible to the big brutes of the construction, mining, petroleum, logging and marine industries—up to 1650 H.P. when turbocharged.

Production has started and complete programming has been established on all new engines. Non-turbocharged engines will be available first, followed later by Turbopower models to complete the power range.

So—now more than ever before, it pays to standardize on GM Diesel power. For whatever you want a Diesel to do, there's a GM Diesel to do it for you—faster, better, at less cost. Truly, here is a whole new concept in Diesel power—the All-Purpose Power Line. Get the full story by writing GM Diesel, Detroit 28, Michigan.



# GM DIESEL

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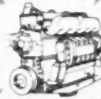
"6-71"  
112 to 252 H.P.



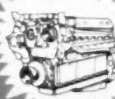
NEW  
"6V-71"  
112 to 252 H.P.



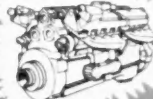
NEW  
"8V-71"  
150 to 334 H.P.



"6-110"  
160 to 335 H.P.



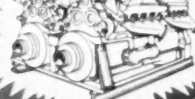
NEW  
"12V-71"  
234 to 504 H.P.



NEW  
"16V-71"  
300 to 675 H.P.



NEW  
"24V-71" (Twin 12)  
448 to 1008 H.P.



NEW  
"32V-71" (Twin 16)  
600 to 1320 H.P.

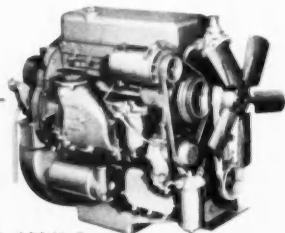
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20 to 1650 H.P. in only 3 cylinder sizes

## NEW SERIES 53

—smaller Diesels millions can use  
2, 3, 4 and V6—20 to 195 H. P.

A scaled-down version of the famous Series 71 GM 2-cycle Diesel—identical in design principles—the new 53 Series incorporates the time-proved features of patented GM unit fuel injection and uniflow blower scavenging in more compact, lightweight units. These spacesaving engines open up whole new fields of Diesel usefulness in trucks, buses, and taxicabs, in marine service, as well as in tractors, generators, loaders, lift-trucks and many other types of industrial equipment.

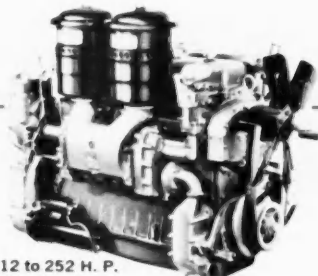


"4-53"—51 to 130 H. P.

## SERIES 71 "IN-LINE"

—the versatile, time-proved economy Diesel  
2, 3, 4, 6, Twin 4, Twin 6, Quad 6—33 to 1008 H. P.

Never, in industrial history, have there been Diesels as versatile and capable as the Series 71 GM Diesels—built in a wide range of Fan-to-Flywheel, Package Power, Torque Converter, Generator Sets, Economy truck engines and Turbopower models. And, because of GM Diesel's unique power concept—a family of engines featuring unequaled parts interchangeability—these time-proved "Jimmy" Diesels become even more valuable as key components of the GM Diesel All-Purpose Power Line. Today's "71" engines incorporate the results of 20 years' continuous improvement.

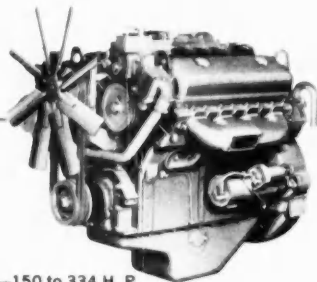


"6-71"—112 to 252 H. P.

## NEW "V-71"

—higher horsepower in smaller, more compact units  
V6, V8, V12, V16, Twin V12, Twin V16—112 to 1650\* H. P.

The new V-71 "Jimmy" Diesels are a further dramatic illustration of GM Diesel's mighty new power concept—rounding out the All-Purpose Power Line—yet retaining the GM family relationship and parts interchangeability. Here are engines destined to give you a better investment-earnings ratio than any you have ever had before. Diesels that boast the ultimate in compactness, light weight, high efficiency, durability, inexpensive maintenance and parts interchangeability.



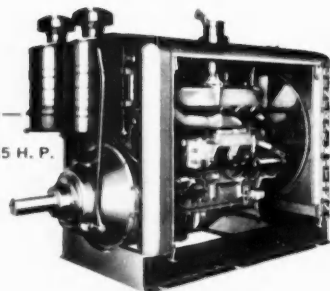
"8V-71"—150 to 334 H. P.

\*Turbopowered

## SERIES 110

—a favorite on heavy-duty jobs  
6-110 and Twin 6-110—160 to 670 H. P.

Renowned for its ability to get big jobs done faster at lower cost, the GM "6-110" has stepped in and taken over thousands of jobs for every kind of business—done those jobs as never before—greatly expanded the usefulness of Diesel power. Built in single- and multiple-engine units, the Series 110 engine is available for a wide variety of heavy-duty applications in earth-moving, oil-field, railroad and marine equipment.



"6-110"—160 to 335 H. P.

GM Diesel  
Detroit 28, Michigan

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When the terrain is not so rough and the tractor cannot be tied up for drilling only, the I-R Dual-Drill rig offers economy and efficiency for fast pipeline work. The Dual-Drill rig is also advantageous when the right of way is narrow. Mounting two heavy duty X71-WD Rock Drills, the Dual-Drill rig sinks two holes at a time with all controls at the operator's fingertips. The two FM-4 Drill Guides, mounted on a rugged, welded steel frame, are available for 8 or 10 ft. steel changes. Built-in air line lubricators, centralized controls and air-powered piston type feed motors contribute to faster, easier drilling.

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***A Constant Standard of Quality in Everything You Need For Drilling Rock***



LEWISTON POWER PLANT

# NEW POWER SCHEME AT NIAGARA

The 1950 Niagara water-use treaty between the United States and Canada allocates more water to power production from the Niagara River. The New York State Power Authority's \$700 million project will claim this country's share.

R. J. Nemmers

**W**HEN the first man of engineering bent gazed at Niagara Falls, it probably took very little time for him to get around to thinking about a way to convert the rushing masses of water into some form of useful power. Serious thinking about developing a part of the total 8,000,000 hp of potential energy at the Falls has occupied men's minds for almost 2 centuries: action on these plans has occupied their hands since 1806 when the first diversion canal producing mechanical power was constructed.

That early development attempt used no more than a few feet of the tremendous total head of water available. Hand drillers and horse-drawn muck carts were utilized in building it. Essentially the same methods were used 75 years later in the construction of the first electric

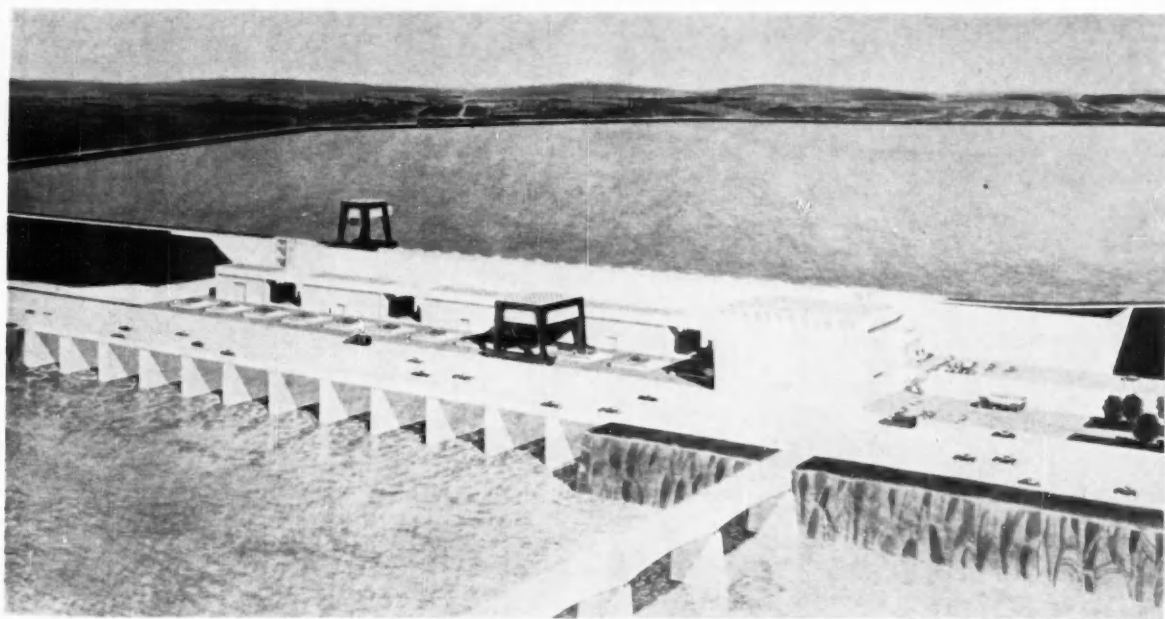
generating plant. Then, in 1897, a scant 18 years after the Edison electric lamp was developed, the first high-head hydroelectric power plant was built by the Canadians at Twelve-Mile Creek. When installed, a total of 10,000 hp was developed. In contrast, the latest scheme to develop power from the drop between Lakes Erie and Ontario calls for the expenditure of about \$700 million, the removal of almost 30 million cubic yards of earth and rock by latest drilling and excavation methods and the placing of some 3,500,000 cubic yards of concrete including about 7,000,000 tons of aggregates.

A net head of 300 feet will be utilized in driving main turbines of 2,600,000 hp (total name-plate rating), which in turn will drive generators rated at 1,950,000 kw. A second plant, utilizing the water

head to be created by pumping to a reservoir during off-peak hours, will generate 336,000 hp to provide 240,000 kw.

The amount of power that will be made available by the Power Authority project seems incredible to most people who view the Falls only from the standpoint of its scenic beauty. Nevertheless, when work is complete, the United States and Canadian generation of power from Niagara, on a firm basis, will be almost half the estimated total 8,000,000 hp available. In contrast, Hoover Dam has an installed capacity of 1,742,000 hp. As a matter of fact, this country's only river system having a kilowatt output greater than that of Niagara is the Columbia, with 4,079,220 kw. Furthermore, Niagara's power is concentrated in a small area as compared to the far-flung dams of other river systems; her





**TUSCARORA PUMP-POWER STATION**

length is but 36 miles as compared to Columbia's 1400. More than half of Niagara's drop is confined to a 5-mile stretch including the Falls, and it is within this area that her potential power is most highly developed. The thing that makes it all possible, of course, is that the river is made up of the discharge of four of the Great Lakes, draining some 248,000 square miles of United States and Canadian lands.

One of the most frequently asked questions by laymen when they hear of the development work now going on has to do with its effect on the scenic wonder of the Falls. The answer is simple—the current work not only will not detract from the esthetic quality of the cascade, it will help to preserve it in years to come. Studies have indicated that the rate of recession of the Horseshoe (Canadian) Falls has been approximately 2.3 feet per year since the turn of the century. As geologic time goes, it is thus apparent that left alone the famed Falls would soon recede all the way to Lake Erie. A considerable time before that would happen, the American Falls would be left high and dry and the cascade would degenerate into a cataract.

The diversion of some of the rushing waters to power production will thus slow the rate of recession. In addition, an ambitious program, aimed at more equitably distributing the water not only between the American and Canadian falls, but across their brinks, is now largely complete. This story was told in a series of articles beginning in *COMPRESSED AIR MAGAZINE* in November 1937, continuing to the most recent one

in September 1955. Other articles have told of the construction of Canada's Sir Adam Beck Generating Station Number 2, pointing out various remedial works undertaken in conjunction with the building of that power plant.

The current power project is aimed at claiming the United States' half-share of the water that the Treaty of 1950 permits to be diverted from the Falls. The treaty calls for maintaining a minimum round-the-clock flow of 50,000 cfs over the brink. During daylight hours of the tourist season (April through October) the flow is to be at least 100,000 cfs. The remainder of the water is to be split equally for purposes of power generation between the two countries with the exception that Canada receives an extra 5000 cfs for waters that she diverts into the Lakes system for that purpose.

Under the international agreement, engineers estimate that there will be an average of 50,000 cfs available to the United States for power generation. The full 50,000 cfs cannot always be relied upon, however. For example, the flow of the river has been so low at least twice that less than 30,000 cfs would have been available under the terms of the 1950 Treaty.

The flow of the river changes not so much because of variations in the level of the four Great Lakes that feed the stream—actually they vary only 1 to 1.5 feet at the most—but rather is due to a quirk of nature. Prevailing winds tend to create considerable differences in the level of Lake Erie. Depending on whether they are from east or west, the level at the mouth of the Niagara can

fluctuate as much as 4 to 5 feet, the winds serving to "pile-up" the water at one end, or the other, of the lake.

One of the ideals of all designers of hydro works, of course, is to assure as nearly constant a power supply as possible, or at least, to time variations to correspond with fluctuations in demand. This consideration has played an important role in the design of the new Niagara power scheme. The situation is essentially one in which more water is available at night, during periods of lowest demand, than during the day, when industry makes its heaviest calls for kilowatts. Accordingly, the design of the plant calls for storing the excess flow at night (and on weekends) for use in the daytime, speaking in very simple terms. A portion of the nighttime supply is to be used to generate power that is used to pump still more water into the 20-billion-gallon Tuscarora Reservoir. During daylight hours, this water is released, generating a certain amount of power on its way back to the forebay area above the main power plant, and, joining whatever daytime water is available, falls through the penstocks into the main power plant.

The essential features of the scheme, then, consist of intake works above the falls; waterways leading to the power plant; a combined motor-pump, turbine-generator facility for handling and utilizing stored water; a reservoir and appurtenant control, pump and generator facilities; and the main power plant including the forebay area, penstocks, switching yards, etc.

The intake structure is to be located



#### LINE-DRILLING RIGS

The two rigs shown in these illustrations team up for effective line-hole work. The 2-drill Ingersoll-Rand line-hole unit at the left puts down two 2 $\frac{3}{4}$ -inch holes between each

pair of 6-inch holes drilled by the double-ended Drillmaster shown in the other view. The 6-inch holes are spaced on 5-foot centers and are 100 feet deep.

about 3 miles above the Falls and will consist of two reinforced-concrete, wide-mouth, harmonica-type structures of 840-foot length. Water will be guided to the intake by an upstream wall 500 feet long, as well as by the so-called Buckhorn Island Training Dike, a 2000-foot-long rock-fill structure. Also involved is extensive excavation of overburden and rock from the river bottom upstream, and 500-foot-wide channelization of the river bed downstream, from the intake structure.

Flow into the intake will be controlled by vertical-lift intake gates, approximately 49 feet wide by 67 feet high. (In addition, emergency stop logs of the same size can be utilized in slots provided for them.) The fixed hoists for the control gates are housed in an above-ground structure measuring 55x26 feet and rising 96 feet over the intake.

Construction work at the intake is being done by Merritt-Chapman & Scott under a general contract amounting to \$65,962,254. Part of that contract also concerns the construction of a 8000-foot portion of the conduit waterways system immediately next to the intake

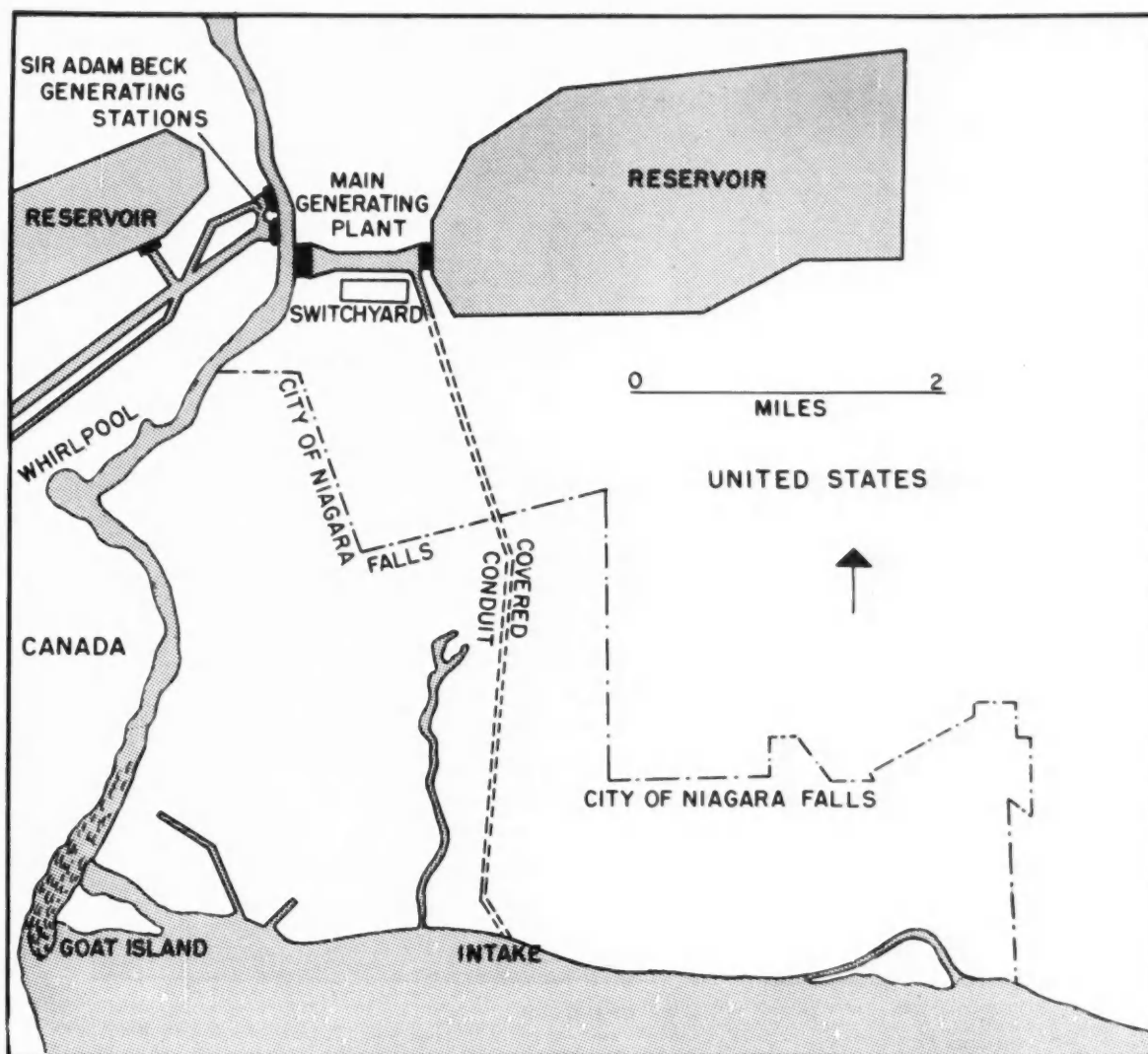
works. On the MC&S job, unclassified excavation will amount to some 7,500,000 cubic yards. Work Section Number 2, which comprises 9000 feet of the twin conduit structures and slightly more than 5,000,000 cubic yards of excavation, was awarded to a joint venture consisting of Edward Balf Company, Savin Brothers and D. W. Winkleman. Bid price was \$37,366,805.

Work Section Number 3 comprises about 5600 feet of the conduit, calls for the excavation of some 4,500,000 cubic yards of unclassified material and is being done by a joint venture consisting of Gull Contracting Company and L. G. DeFelice & Son at a bid price of \$29,861,840.

The twin-tube conduit section of the waterways measures approximately 22,000 feet in length, and the tubes are to be set in bedrock on a line ranging from 85 feet to 155 feet below the surface. The horseshoe-shaped tubes are of reinforced concrete construction, 46-feet wide by 66-feet deep. They are being constructed by the cut-and-cover method. Fill not required for covering is to be used in part in the construction of

the reservoir, and in part as fill for the construction of a new highway—the Niagara Parkway approach to the Falls proper. Work Sections 1 through 3 cover all of the work on the conduit portion.

Water emerging from the twin tubes will pass through a transition structure into an L-shaped open canal which includes the Tuscarora Reservoir forebay afterbay, the transition structure leading to the main (Lewiston) power plant forebay and the Lewiston forebay. Most of the work on this phase of the operation is covered in Work Section Number 4 which calls for the excavation of some 9.5 million cubic yards of earth and rock. Tuscarora Reservoir itself will encompass a 2600-acre plot on the high plateau about 1 mile from the Lewiston power plant and the river. Its construction calls for the placement of some 3,800,000 cubic yards of rock fill in the surrounding embankments, the removal of about 700,000 cubic yards of overburden and rock from the reservoir itself and the handling of almost 2,500,000 cubic yards of earth for the embankments and for the compacted bottom of



the pool area. Work is being done under a \$31,855,000 contract by a joint venture firm, "Channel Constructors," consisting of Peter Kiewit Sons' Company, Morrison-Knudsen Company, Inc., Perini Corporation and Walsh Construction Company.

The Tuscarora Pump Power Plant, as we have indicated, will force water from the waterways canal into the reservoir during periods when water supply exceeds demand. The water will then be released under opposite conditions, generating power as it flows back into the waterway system. The pump turbines are of modified Francis-type and each of the twelve units has a rating of 3400 cfs as a pump and 28,000 hp as a turbine. The motor generator units are rated, as motors, at 37,500 hp and, as generators, at 25,000 kva. As pumps and motors the units rotate counterclockwise at 112.5 rpm; and as turbines and generators, clockwise at the same speed. The con-

tract for the 971-foot-long and 145-foot-high structure has been awarded to the joint venture of The Arundel Corporation, L. E. Dixon Company and The Hunkin-Conkey Construction Company at a bid price of \$39,834,292.

The Lewiston Power Plant will be of the semi-outdoor type. Thirteen turbine-generator sets, each providing 200,000 hp, will be installed at the foot of a like number of concrete-encased steel penstocks 24 feet in diameter and approximately 480 feet long. Power is to be produced at 13,800 v and relayed to the switching yard near the forebay where it will be stepped up to 115,000 and 230,000 v for transmission. The power plant structure will be recessed into the sheer walls of the gorge—an operation that requires the removal of an estimated 9.75 million cubic yards of earth and rock. The facility itself will require 1,280,000 barrels of cement and 60 million pounds of reinforcing

steel. It will be 1840 feet long, 376 feet high from the intake deck to the tailrace and will have an over-all depth of 550 feet.

The contract for the power house was awarded to Merritt-Chapman & Scott for a record, single-contract, single-contractor price of \$98,288,498. Awarded February 10, 1958, the contract provides for completion by July 1, 1962.

Because the construction crosses an area extensively used by railroads, streets, transmission lines, and homes and businesses, almost \$5,500,000 is being spent on specific relocation and clearing projects alone. A joint venture (Buffalo Electric Corporation and Patterson-Emerson-Comstock Company) has received a \$4,042,350 contract for the relocation of transmission lines. W. J. Irwin & Sons has received a \$1,267,491 contract for the relocation of some 72 homes, including the general development of an 80-acre subdivision in which



#### CRAWLERS

There are literally hundreds of rock drills currently in use on the Power Project. Besides the specially-built line-hole rigs and self-contained primary blast-hole machines, crawler-track-mounted units also handle some line-hole drilling

as well as blast-hole work. The machines shown in this view are Ingersoll-Rand Crawl-IR's being supplied with air by a battery of Gyro-Flo 600 compressors. Most portables in use are either of 600 or 900 cfm capacity.

the displaced residences are being relocated. S. J. Groves & Sons has a \$159,121 contract calling for the construction of a haul road for moving the houses from their present location to the new one. These are in addition to extensive relocation works incorporated in the major construction contracts.

With the vast amount of rock work to be done on this job, it is perhaps natural that some innovations in drilling techniques have been realized. Line drilling, for example, has been speeded and its accuracy stabilized with the development of some multi-drill rigs featuring self propulsion as well as power alignment of the drills. Line-drilling and blasting techniques play a governing role in the construction of the power project because of the canals and cut-and-cover conduits. Walls of these must be as nearly straight and vertical as pos-

sible and the amount of overbreak limited to the very minimum. In the case of conduits, vertical walls carefully aligned will reduce considerably the amount of concrete required to form the tubes. The first coordinated line-drilling machine to show up on the job was an Ingersoll-Rand SCM6 4-drill unit on the Merritt-Chapman & Scott powerhouse contract. Mounting D-45 drills on 26.5-foot towers (for 20-foot steel changes), the rig is composed of the standard traction gear for the firm's well-known Drillmaster drills; a 25-foot-long carriage frame on which is mounted a traveling drill support carrying the four drill guides, rigidly positioned on 18-inch centers; and the necessary equipment and remote controls necessary to the spotting and running of the drills. The carriage frame is suspended on pivots from two Benton Harbor large-

diameter-bore hydraulic cylinders positioned at a 90-degree angle to the axis of the machine, thus making it possible to advance and retract the entire frame and even to turn it slightly on the pivots from side to side. The drill support moves along the carriage frame driven by a chain feed. Vertical alignment of the drills is accomplished by means of four standard Drillmaster jacks of 48-inch stroke, one at each corner of the rig. Built-in levels at the control station assure accuracy in leveling the machine. Power cones on the drill guides lower them into drilling position.

Completely air-powered, the rig is served by a total of eight air motors. Four I-R BBFM units feed the drills, another similar one drives the feed chain for positioning the drill support along the carriage frame, two more type H5DP-2 units serve to propel the entire





#### PORTABLE BATTERY

Because of the great amount of rock drill work along the Power Project, many contractors are setting up batteries of portable compressors to furnish compressed air to a number of drills working in one area. Shown is a group of three Ingersoll-Rand Gyro-Flo 600 units on one of the conduit sections.

machine and a size 5MQ-3 drives a Vickers hydraulic pump.

With these features, set-up time is considerably reduced over single drill methods. The rig is positioned, within approximately 3 feet of line and with the carriage frame within a few degrees of alignment, by means of the crawler propulsion gear. After leveling, the carriage frame is advanced and turned to line up exactly with the surveyed line. The drill support frame is then shifted to one end of the carriage, the drill guides lowered and drilling starts. When the holes are bottomed, the drill guides are raised and the support frame repositioned. On the MC&S job, the drills are shifted 9 inches after the first set of holes is drilled out. With the rig then, it is possible to drill eight sets of four holes each on 9-inch centers along the 25-foot carriage frame before it is necessary to re-

position and realign the machine. The time savings in such a setup are readily apparent and similar rigs are now in use or planned for other jobs on the power project.

Merritt-Chapman & Scott, for example, has another machine similar in every respect to the first one, as well as two 4-drill units with 25-foot steel change towers which are in use on the intake contract. Channel Constructors is utilizing one having two drills, but with drill guides enabling 22-foot steel changes. The joint venture firm of Gull-DeFelice has two 4-drill units with towers for 30-foot steel changes. Tuscarora Contractors has a 4-drill unit equipped with guides enabling 20-foot changes of steel.

Channel Constructors also has another type of line-drill rig that is illustrated herewith. Essentially, the



#### BLAST-HOLE DRILLING

Primary blast holes along the conduit sections and at the intake and forebay areas are being put down a minimum of 40 feet after overburden is removed. Crawler-mounted units utilizing standard percussion drills to sink 3- to 4½-inch holes are common. Self-contained units, such as the Drillmaster shown here, are also being utilized. This unit, equipped with a down-the-hole drill powered by a Gyro-Flo 600 compressor mounted on the chassis is putting down 6-inch holes on Section 3 (Gull-DeFelice). Two steel changes result in a 40-foot-deep hole. A special tower mounting two D-45 drills is also on hand for this machine.

unit is a double-ended Drillmaster. The Ingersoll-Rand-built rig is made up of the firm's standard Drillmaster traction equipment on which are mounted two drilling towers—one at either end. Designed either for rotary or percussion drilling, the contractors are utilizing the device to sink 100-foot line holes of 6-inch diameter. The rig does not carry its own air supply as do the firm's other standard Drillmaster machines.

Along the waterways route there are a number of other pieces of rock drilling equipment. Selby Drilling Company (which has subcontracts for diamond drilling and grouting from several of the project contractors) utilizes a special tower that mounts on the trunnion of its Drillmaster. The tower carries two vertically traveling D-45 drifters on 10-foot steel-change towers to drill two 3-inch holes on 8-foot centers at one time.



#### LINE-HOLE-RIG AND ROCK FACE

Shown above is Merritt-Chapman & Scott's drill set-up consisting of four D-45 drills on 20-foot steel-change towers. The Ingersoll-Rand rig is putting down 3-inch holes on 9-inch centers. The insert illustration shows the smooth clean face after blasting.

#### OVERLOOKING THE GORGE

View of the Merritt-Chapman & Scott Powerhouse contract. The gorge cut by the short but mighty Niagara River provides a fitting backdrop for this construction scene. Some 30 million cubic yards of earth and rock will be removed on the over-all job.

Gull-DeFelice has a similar tower to mount on its Drillmaster for drilling anchor bolt holes. In addition, percussion blast hole machines mounted on crawlers as well as some line-drilling crawler-mounted wagon drills are in use, and of course, portable compressors abound.

The rock being drilled over most of the job is Lockport Dolomite which exists in a nearly horizontal layer over parallel ones of limestone and sandstone, as well as one of shale. (The so-called Queenston shale appears at the bottom of the gorge.) Overburden is largely composed of red and brown clays which comprised Lake Dana-Lundy, a body of water which geologists estimate existed some 10,000 to 50,000 years ago when the Ontario Basin was blocked by ice and Lake Erie drained toward Rochester, N. Y. and the Genesee River. Remnants of the lake are still present in the form of swamps.



#### SERVICE CONNECTIONS

Without stopping vehicular or pedestrian traffic, Laclede has found a way to make service connections. Key to the operation is the compressor construction truck that is assigned to the job. It carries an Ingersoll-Rand Type 40 compressor. Eighteen of these trucks are equipped with I-R drills with water feed for earth boring jobs. To do a portion of the work, an I-R T-handled spade is used (right) to excavate for the main.

## Better Service To The Customer

### Air Tools Speed Repairs Of Gas Company's Lines



**M**OBILE air power is helping Laclede Gas Company, St. Louis, Mo., maintain its facilities and meet surging public demand for natural gas. Fifty-eight compressors furnish the air for a wide variety of tools, all of which are being broadly used in imaginative applications.

Laclede was first organized in 1857 to supply gas for street lighting in a bustling frontier town, and since its founding days, has matched its own expansion with that of the city. Today, it furnishes natural gas to customers in about 160 square miles of St. Louis County. Its most recent venture, that of storing gas in a virgin underground formation, was described in COMPRESSED AIR MAGAZINE's April 1958 issue, as were some of the company's progressive theories and history. Meeting the fast-growing demand for gas service, particularly for space heating, is possible because of its increased capacity. The facility is accepting all new construction house-heating customers and 5000 conversion customers at the same time, so long as it is consistent with its storage development. With such a spectacular expansion in a comparatively few years, it is easy to understand the burden of maintenance and construction that has been placed on Laclede. To ease its work, the facility has turned to pneumatic tools.

Varied combinations of equipment have evolved for the most efficient application of air power to the four major activities of the company: emergency leak repair, programmed maintenance of

old mains, installation of new mains and making service connections.

For repair work, there are 36 leak trucks, each with its own air compressor and tools, 16 compressor trucks with tool compartments and 6 compressor-construction trucks that not only mount a compressor, but can move a construction crew and its tools swiftly and efficiently. All trucks are equipped with Ingersoll-Rand air compressors.

In addition to the basic compressor, a typical leak truck carries an I-R Jackhammer, two PB8 paving breakers, two Size 34 backfill tampers, a Size 159 T-handle spade, a sump pump and a pressurized air mask. The heavy-duty tools speed locating leaks, repairs and restoration of the surface. As an indication of the service improvement they have made possible, it is estimated that a man with a pneumatic spade can loosen hardpan or frozen earth in one-tenth the time it would take to do the job with a hand pick. Laclede is continually experimenting with and refining the design of its leak trucks and air equipment.

As indicated in our earlier article, Laclede acquired a number of smaller gas companies in its expansion program. Where possible, it utilized existing distribution mains. Today, these mains extend more than 1500 miles throughout the service area; and, together with meters, regulators and the like, represent more than three-quarters of the company's total plant investment.

Increased demands for gas have taxed these old cast iron mains, and Laclede

has met this problem with an extensive program of bell joint leak clamping. Paving breakers are used to break concrete or asphalt surface, and clay diggers loosen compacted earth, clay or frost to expose the bell joints. The surface of the joint must be clean and smooth to provide the gasket with a good seat, thus assuring a leak-proof connection. When the program was started in 1952, the men used hand chisels and files to remove rust and smooth the joint. In the third year of the program, triple scalers were introduced. Utilizing these air tools, four crews, totaling 75 men, have installed leak clamps on 4200 joints in a single year. Laclede engineers report that the use of these pneumatic, 3-piston scalers not only speeded the work, but improved the quality of the job as well.

When necessary, final smoothing can be done with a Size 3F45 surface grinder equipped with either a 7-inch sanding disc or a 6-inch cup-type wire brush. Laclede has tried sandblasting bell joints and hopes to adapt an air-driven suction blower to recover the sand.

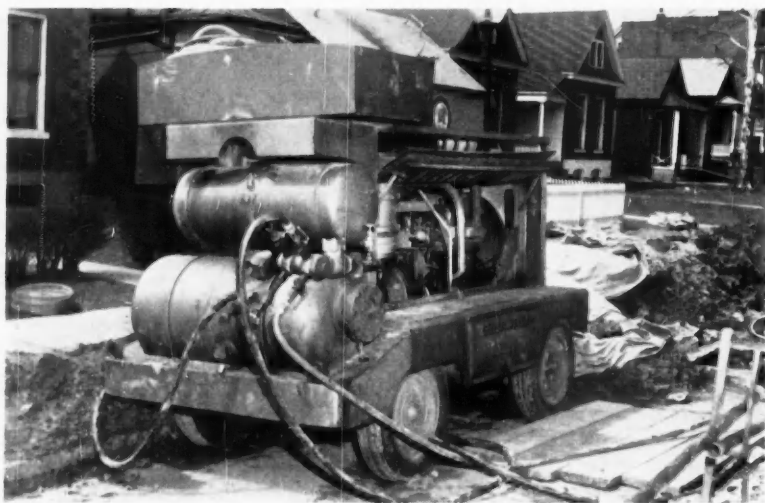
Laclede was a pioneer in the development of earth boring for both the installation of mains and service connections. There are certain obvious advantages, among them a saving in time and labor, little or no interference with traffic and minimum damage to lawns and pavements. The company started drilling under streets about 28 years ago, using an I-R Type B air drill, a fishtail auger bit cut from a section of automobile spring leaf, boat propeller-shaft stuffing





#### PROGRAMMED MAINTENANCE

As a part of Laclede Gas Company's regular maintenance program, it maintains customer service even though many of the existing mains have been in place for a number of years. To do the job, air power is provided, for one section of a bell joint leak clamping job, by the Ingersoll-Rand Gyro-Flo rotary air compressor illustrated at the right. It furnishes air at 210 cfm to a variety of pneumatic tools. For instance, openings in the pavement are cut with the I-R Size PB8 paving breaker to expose bell joints, above, at the left; and, after installation of the leak clamp, holes are filled and the earth compacted with the Ingersoll-Rand Size 34 backfill tamper top, right.



boxes and suitable hollow shafting to carry water to wash back the cuttings. Initially, water was introduced through the spindle of the drills; but when this model was discontinued, a water feed was developed to introduce water on the drill rod side of the unit. The company uses 4J, 4K and 4SM Multi-Vane air drills in this manner. (The manufacturer now offers standard 33SM54 and 44L54 reversible earth boring motors with water attachments for this service.) Laclede uses 20-foot lengths of extra-strong  $\frac{3}{4}$ -inch pipe for drill rod.

One of the many notable jobs accomplished by Laclede crews was a 330-foot boring for installation of a new, 1  $\frac{1}{4}$ -inch line. Pavements were opened only where necessary to make service connections.

To best describe the operation, a look at the actual report, made in 1944, will do the best job:

*Arrived on job with crew of 8 men, compressor operator and compressor at 9:30 A.M. on May 2, 1944. Broke macadam pavement and dug openings the rest of the day. A heavy rain fell during the night and the openings filled with water which had to be bailed before drilling could be started. Began drilling about 9:15 on May 3, 1944. Completed drilling at 11:40 A.M. Completed installing pipe by 12:05 P.M. A 330-foot hole was drilled and reamed in just 2 hours and 25 minutes. It took only 25 minutes more to install the 330-foot (length) of 1  $\frac{1}{4}$ -inch pipe.*

Boring is the predominant method

used by Laclede for installing service connections. Of the last 10,000 connections made, at least 7500 were accomplished with I-R drills in this manner. Where possible, the bore goes directly from the customer's basement, under the lawn, walk and street, to the gas main. The basement wall is drilled with a Jackhammer, and then the air drill is put to work. Only two or three openings are required; one at the main to make the connection; another near the curb to serve as a sump for wash-back water and dirt and to permit alignment of the drill rod; and, in the case of a completed or occupied house, another wash-back water sump outside the basement wall.

When Laclede started service connection boring, a hand auger was used.



### LEAK REPAIR WORK

Leak detection and repair work is a vital segment of any gas utility. To expedite its work, Laclede uses a standard leak truck, shown at the right with its integrally mounted Ingersoll-Rand Type 40 compressor and some of the air tools. The latter standing along the truck, are detailed in the photograph, below right. They include, from left to right, a Size 159 T-handled spade, two Size 34 back-fill tampers, two PB8 paving breakers and a J30 Jackhammer. Part of the equipment on a leak truck is an I-R air-driven sump pump (below) that is used to remove water used in locating leaks.



With the air drill, the required time is halved and two men, formerly needed on the job, are released to do other work. Today, the company has eighteen trucks, nine of which are equipped with truck-mounted compressors. They are also equipped with drilling rigs complete with water feed for service connection operations. On a line replacement job in the county, a crew of six men can go down the road, from house to house, drilling 30 feet under the lawns and another 20 feet under the streets, making the necessary surface openings and completing from three to four service connections in a normal working day.

A variety of air tools are available for the men so that they can more easily

cope with the individual conditions of each job. They include Jackhammers, paving breakers, spades, tampers and, of course, the earth boring drills. (The boring machine can also be utilized to power reaming tools for cleaning old service pipe prior to pulling in new copper pipe—a part of the renewal program.) Variations of these air motors can be used effectively for vertical drilling 2-inch holes for leak testing as well as 10-inch ones for installation of ground rods for cathodic protection of transmission lines.

Air tools have a number of inherent advantages for gas utility service. They are sturdy enough to take the inevitable beating of all-weather work in the field.

Even when overloaded, an air motor, whether on a drill, wrench or hoist, cannot burn out. Air tools are explosion proof, an important safety factor. Laclede has found that air power means swifter work, better job quality, less burden on the men and more efficient utilization of man power—all making for better service to the Laclede customer. Some of the techniques pioneered by the St. Louis utility have become standard in the industry. Some, originated elsewhere and in totally different industrial fields, have been adopted eagerly by alert Laclede engineers and management. There is always an evident willingness to try new uses for compressed air in an effort to improve operations.

# UNION

Built On Geodesic Principles, This Structure Pioneers A New Approach To Industrial Buildings

Peter Sleight



## A GIANT UMBRELLA

By comparing the sizes of the vehicles in the foreground of the aerial view and the close-up illustration with the Union Dome, it is easy to see why the structure is large enough to enclose a football field within its walls. The base diameter is

384 feet, and the building rises 120 feet—as high as a 10-story office building. It is made of 6-sided steel panels, welded together and strengthened by a network of rods and pipes. It is totally without internal supports.

# DOME

**A** GIANT yellow and blue dome that recently was raised just north of Baton Rouge, La., serves as a regional tank car repair and maintenance facility for Union Tank Car Company. It is the first major industrial application of the geodesic dome principles of design, and it is thought, in some quarters, to be the start of a new era in industrial building construction.

The first such building to be fabricated entirely of steel, the Union Dome rises 120 feet and has an over-all base diameter of 384 feet. It is without internal supports; and in its 110,000 square feet of unimpeded floor area, either a

football field or a major league baseball diamond could easily be contained. This is an indication of the potential uses of dome-type structures. Enthusiasts foresee them enclosing not only sports arenas and athletic fields, but school and civic auditoriums and office buildings as well. They may serve as economical and efficient factories and industrial buildings. There are many factors that make geodesic structures favorable, especially in the last two named applications: they include economy of cost per square foot of floor space covered; visual control of all work areas from one central point; unimpeded materials and work flow; flexibility of work space; concentration of activity in a compact circular layout; ease of heating, cooling, lighting and ventilation; speed of erection; low maintenance costs; reduced risk of obsolescence; and adaptability for construction on virtually any type of soil. The majority of these factors are exemplified by Union Dome.

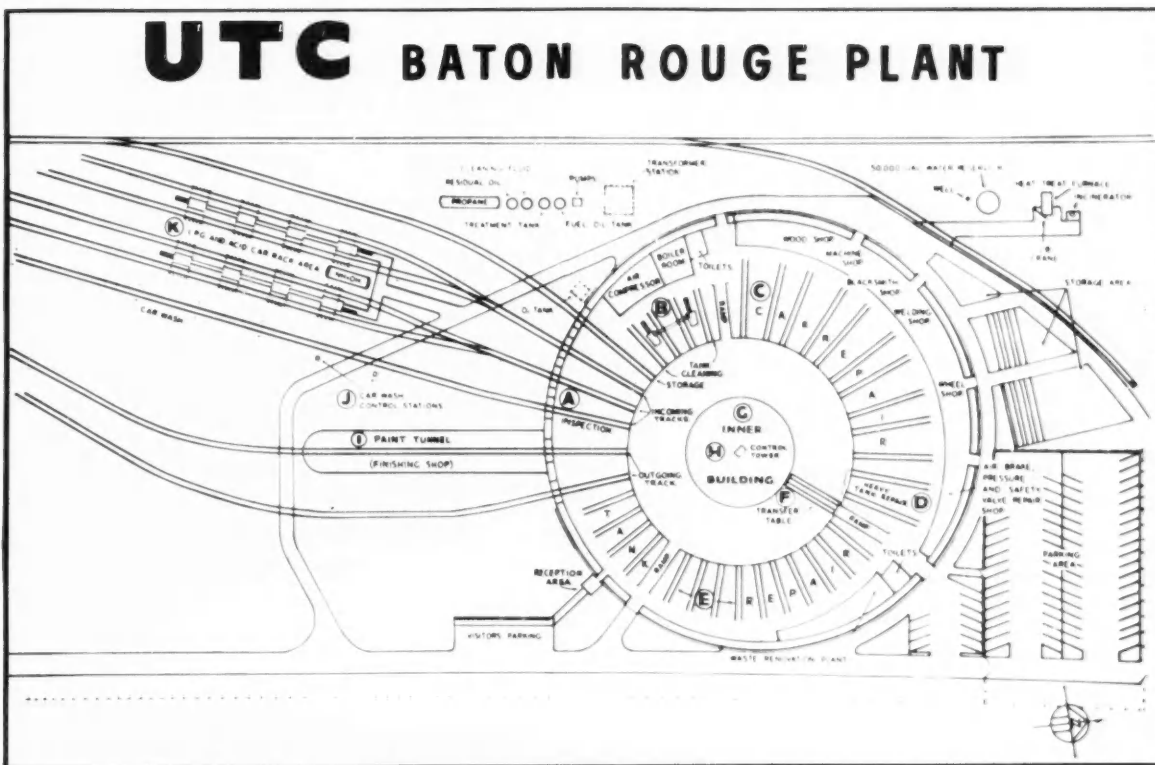
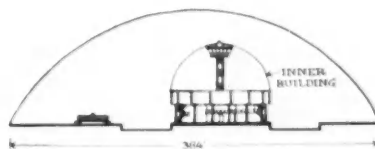
The design of the structure was worked out by Union Tank's Depart-

ment of New Plant Development & Operations, headed by project engineer R. A. Lehr. Coöperating in the plans was Synergetics, Inc., of Raleigh, N. C. The building is based on patents held by R. Buckminster Fuller, designer of the Dew Line domes of the U. S. Arctic radar warning system. Battey & Childs, Chicago, Ill., did the general engineering and Nichols Construction Company of Baton Rouge was the construction contractor. The final cost was well under \$10 per square foot of floor area covered, or less than \$1,000,000. The entire project, including the most modern tank car repair and maintenance facilities, cost slightly more than \$3,000,000 and was a part of Union Tank's \$200 million expansion, modernization and diversification program that began after World War II.

The dome is more accurately described as a quarter sphere, designed and constructed of steel as a 3-dimensional curved truss. The truss, approximately 4 feet deep, is designed as a unit cell system of octahedra, in which involution 11-

## BATON ROUGE PLANT

The track plan and maintenance and repair stations of Union Tank Car Company's Union Dome shows: (A) the point at which tank cars, upon entering the structure, are inspected to determine what repairs are needed; (B) four track positions where the interiors of tank cars are cleaned; (C) ten track positions for tank cars undergoing general repair; (D) two tracks for heavy repairs to tanks; (E) fourteen positions for light repairs; (F) the transfer table that travels in a circular course between the inner building, at figure "G" and the repair areas (the table accommodates one tank car); (H) the control tower at the top of the inner building; (I) the paint tunnel; (J) the car wash control stations; and (K) the LPG rack area where cars that carry liquefied petroleum gas or acid are cleaned with special solutions. The sketch at the right is of the elevation.





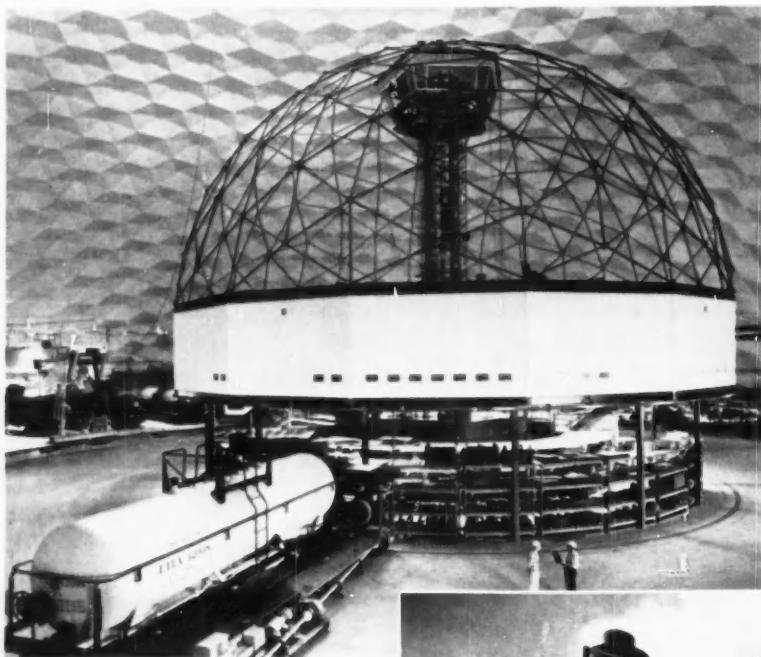
gauge sheet steel surface material is utilized both as the weathering surface, and as the inner member tension system. The outer hexagonal array is composed of 4-inch steel pipe sections approximately 9 feet long, positioned with  $\frac{3}{4}$ -inch tension rods. The compression pipe elements and the tension rods lie along the typical geodesic great circle grid lines. The sheet steel fold lines repeat the geometry of the pipe and rod systems. Despite the seeming complexity and size of the structure, only seven items appear on the bill of materials: standard 11-gauge ( $\frac{1}{8}$ -inch) sheet steel, 4-inch pipe,  $1\frac{1}{2}$ - and  $\frac{3}{4}$ -inch rod, 2-inch pipe sleeve and  $1\frac{1}{2}$ -inch nuts and washers.

Union Dome consists of 321 hexagonal

steel panels welded together to form a total surface area of 154,900 square feet. The sections are strengthened on the outside by the interlocking system of rods and pipes. There are twelve slightly different shapes and sizes of panels averaging approximately 30 feet across. They were fabricated at the construction site starting in the latter part of 1957. Erected entirely without the use of scaffolding, the panels were lifted by cranes and brought into edge contact for welding. Work was begun at the base and continued concentrically to the zenith. In relation to its size, the completed 567-ton structure has a thickness of less than that of an eggshell. At no point does it place more weight on its foundation than does an automobile tire on the ground.

When finished, 6000 gallons of paint, in twelve colors, were used for the exterior, interior and equipment of the dome and its related facilities. The outside is yellow and blue. Yellow was selected to reflect heat on sunny days, thus accentuating the panels' tendency to be in tension, or shrink. The outer framework of pipes and rods is painted blue to absorb the heat, thus increasing the compression, or expansion, tendency of the framework. Inside, the walls and ceiling are painted off-white for better illumination, and the various pieces of moving and stationary equipment are painted with contrasting colors to aid in identification and promote safety. George S. Hunt, of New York City, was the industrial designer. He selected not only the paint colors, but designed the layout of the administration offices, reception room and the paint tunnel, as well as the landscape of the entire area.

The interior is lighted from within, since the only source of natural light is at the doors. The main source is known as a "wheel of light." It is 332 feet in diameter and consists of a circle of 106 color-corrected mercury-vapor lamps. Although they burn at only 1000 w, they are said to be the most powerful reflector lamps in existence. The "wheel" is suspended 34 feet above the work areas and floods them with 50-foot-candle illumination, as compared to 30 foot-candles in conventional factory buildings. Sixty additional lamps, with peach-colored filters, are beamed at the ceiling for a warm, diffused indirect light. Abe Feder was the lighting consultant. He came to the job with a vast and varied background, having previously done similar work for the United Nations Building, the New York International Airport and



#### TO CLEAN A TANK CAR

Tank cars routed to Union Tank Car Company's new repair facility are moved about by a Whiting Trackmobile (right), a vehicle that is equipped with both rail and road wheels. Before entering, a car is cleaned at a washing station. It is then placed on a transfer table and rotated to one of 30 specialized repair stations. Guiding the entire operation is the work coordinator, who can watch all the work from his position inside the dome-within-a-dome (above.) This inner building houses the nerve center of the repair operation, and at its top, a central control tower. The transfer table is shown in the foreground, and some of the materials storage area can be seen underneath the enclosed portion of the inside building.





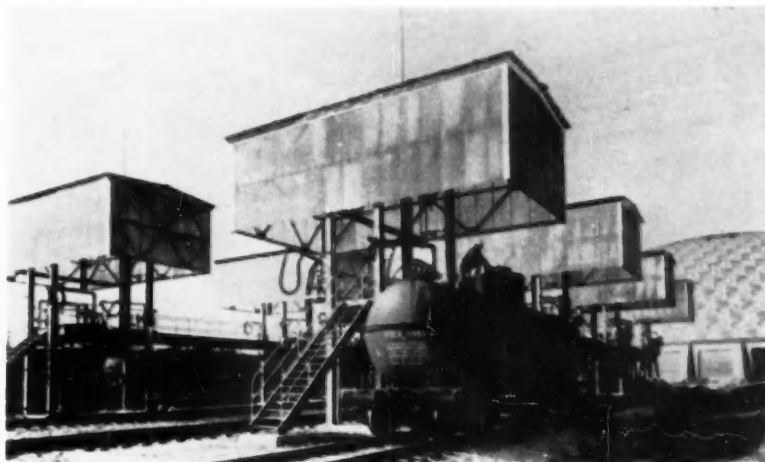
the Coliseum, as well as the current stage success, *My Fair Lady*.

Inside Union Dome is a second geodesic structure, 80 feet high and 100 feet in diameter. It houses the administrative offices, employee quarters, materials storage and a control tower. It is the hub of the repair operations, and encompasses 7500 square feet of floor area.

At the ground level of the building-within-a-building is an open area for storage. At a level 9 feet above this is an open-deck mezzanine and an enclosed office for storehouse personnel and the plant's extensive telephone dial system. The main floor of the interior structure is 18 feet above the ground level and is supported by a ring of 15 steel pillars. It provides general administrative offices, reception and dining rooms and a locker-shower facility. Above the main floor is a concrete observation deck that also will permit construction of additional offices should expansion be required.

The glass-enclosed control tower is the nerve center of the operations. From the height, it overlooks the entire plant area and provides visual control of all operations. A closed-circuit television arrangement provides the men in the tower with screenings of individual inspection activities that take place as the cars enter the dome.

The control tower is the headquarters of the work coordinator who is in touch with the inspection area and all tank car repair stations by telephone. Around the inside of the tower is a desk-high plastic-coated shelf that is divided into sections to correspond with the tracks on the main floor. By marking on the plastic surface with a grease pencil, the coordinator is able to keep an up-to-the-



#### LPG RACKS

Before entering the dome for repairs, tank cars that carry liquefied petroleum gas or acids are cleaned at these special liquefied petroleum gas racks.

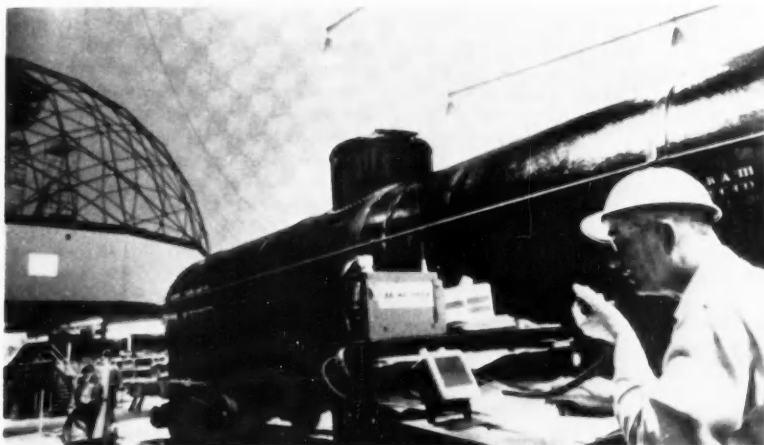
minute status record of each car and track.

As the car approaches the dome, its exterior is cleaned at a wash area near the exit of the paint tunnel. If the car is used for LPG (liquefied petroleum gas) or acid, it is cleaned at a special rack. Upon entering the dome, the car is inspected to determine what repairs are needed. The inspectors relay a report of the work that must be done to the coordinator who enters the information in a Friden Flexowriter Programatic system that has been especially adapted for car repair work. It is used to maintain automatic programming, control and record of all repair operations.

The car is then taken aboard a trans-

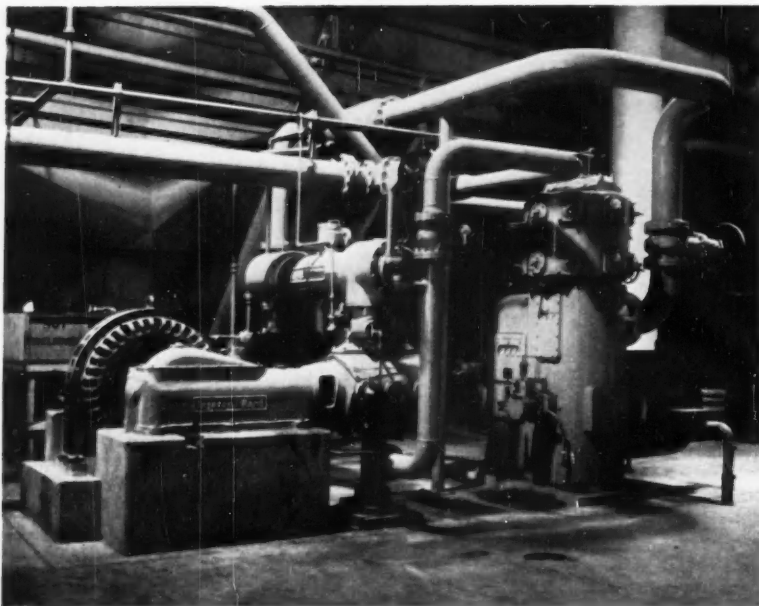
fer table by a Trackmobile that is equipped with both rail and road wheels. The driver operates the transfer table from the seat of his vehicle. The tank is delivered to an assigned repair track position. All repairs are made inside the dome, the car being moved from station to station via the transfer table.

The revolving table, key to the operation, carries only one car at a time. It operates on a circular path, 50 feet wide, between the center of the structure and the repair areas. Although the dome accommodates only 36 cars, fewer than conventional repair shops of similar size, it has two to three times greater capacity because of the layout and improved equipment and facilities. The majority of the materials used for repair work are stored on the ground floor of the center structure in an area that corresponds to the hub of a giant wheel. The tank cars are repaired in specialized track positions that correspond to the spokes of a wheel. Thirty of these tracks are for repair work, three are entrances and three are exits. Of the first group, fourteen are utilized for light tank repairs, another two are for heavy repair work, ten are for car repairs and four for tank cleaning. This arrangement brings every area, on a total of nearly  $\frac{1}{2}$  mile of repair track, within 50 feet of the storage area and cuts materials handling costs and time by a substantial percentage. Other materials and auxiliary repair shops are located around the perimeter of the wheel, near the areas they serve. Because the hub of the track wheel is located 25 feet off center, a large crescent-shaped area is left for wood-working, machining, forging and welding shops. The area is also utilized for the boiler house, the two compressors that make up the compressed air plant and a waste renovation plant.



#### COMMUNICATION IS THE KEY

Within the dome, connecting all work stations and the control tower, is a vast network of dial telephones and a closed television circuit. By this means, supervisors at the work stations can call for material and keep the work coordinator in the tower informed as to the status of each tank car and the availability of the tracks for new cars.



#### AIR SUPPLY SYSTEM

Two Ingersoll-Rand compressors supply air for the various needs about the Union Dome repair facility. One is a new unit—an 18½x11½x8½ XLE-2 that is driven at 514 rpm by a General Electric 200-hp squirrel cage motor. It is shown to the right in this illustration. The unit to the left is an older one, having been moved to the new facility from Union Dome's area at an Esso refinery. It too is of Ingersoll-Rand manufacture. The compressor is a 15½x9½x10 XRE-2 unit driven by a 125-hp synchronous motor. In the background can be seen the familiar light-and-shadow pattern on the walls of the geodesic dome.

Compressed air, at a nominal 100-psig pressure, is used for powering pneumatic tools and for painting and cleaning operations. It is furnished by an Ingersoll-Rand 18½x11½x8½ XLE-2, driven at 514 rpm by a General Electric 200-hp, 480-v, 3-phase, 60-cycle direct-connected, squirrel cage motor. Starter and control equipment is also of G-E manufacture. The compressor, having a piston displacement of 1352 cfm, discharges through an I-R 77-PL-12 after-cooler to a vertical receiver. The air intake is equipped with an Air Maze filter.

An older, 15½x9½x10 compressor is also of Ingersoll-Rand manufacture. It is an XRE-2 unit, driven by a 125-hp synchronous motor. It furnishes additional air for repair work and was moved to the new location from an older Union Tank Car Company area at an Esso refinery.

A 30-ton gantry crane, capable of lifting an entire tank car, straddles the car and heavy tank repair areas. Each of the car repair tracks has its own 1-ton gantry crane for lifting work previously handled manually or with lightweight, portable equipment. Underneath each track is a hydraulic jack pit, similar to those found in automobile gas stations, that can jack up a tank car in 7 minutes. Previous methods took 40 minutes. Utility stations at each pair of tracks provide

compressed air, water, steam, propane and oxygen from overhead lines.

When completed, the car is moved by the transfer table to one of three exit tracks: one of the sets of rails returns it to a tank car storage area; a second, to service; and the third leads through the paint tunnel where painting and stenciling are done.

This layout solves two major bottlenecks of conventional straight-line repair shops: the great distance from materials storage to most repair spots; and slowed work because the car that takes the longest amount of time for repair determines the speed of the entire straight line. The biggest problem of railroad car maintenance in a concentrated area is the cars themselves. They are heavy, cumbersome and, because they can move only on rails, go in but two directions. Because of this, to move one car in a straight-line layout, an intricate switching apparatus is needed. Union Tank solved this with its Whiting transfer table.

The paint tunnel, or finishing shop, connects to the main dome, and is 200 feet long, 40 feet wide and 20 feet high. It covers one of the outgoing tracks and is the last stop for those cars requiring painting. A special air-operated Vacublast grit-blasting unit prepares the cars for the coating in 6 to 7 minutes, an operation that formerly required 4 to 8 man-

hours. After cleaning, the car is sent through a preheat oven for controlled and quicker drying of the paint. At the paint area, workers on both sides of the track have scaffold elevators that move up, down and sideways. Thus, the need to climb up and around the car is eliminated. Paint is applied at a temperature ranging between 130° and 160°F. The last stop in the paint tunnel is for stenciling, an operation that has been greatly facilitated by the use of magnets and a photographic slide projector. The over-all operation in the paint tunnel can be done in 2 to 3 hours, compared to 3 working days under conventional methods.

The significance of such savings and efficiency accomplished by Union Dome and its facilities lies in the fact that tank car repair and maintenance costs are Union Tank's biggest single expenditure. Union Tank Car Company, owner and lessor of the world's largest fleet of railroad tank cars, was incorporated in 1891, succeeding to a business that had been carried on almost from the time the first commercial oil well was brought in by Colonel Drake in 1859. As the principal car line operator serving the petroleum industry, Union Tank has shared extensively in the growth of that industry. While the greater part of Union Tank's revenue still comes from the shipment of petroleum products, the company, in recent years, has been developing significantly as a builder and lessor of tank cars for handling other bulk liquid products.

In the last decade, Union Tank's rolling stock has increased from 42,000 to 57,000 cars. Of these approximately 6000 were added during 1957, including the purchase of 4000 cars from Sinclair Oil Company, the largest single tank car transaction in the history of the industry. During the same 10-year period, the carrying capacity of the fleet rose 45 percent, and its income from sales and services from \$19 million to \$63 million. Net income during the same period increased from \$4,000,000 to \$8,250,000.

Union Tank's steady growth for more than a half century was accentuated after the Second World War. Now, with its first big dome already in full and active use, Union Tank Car Company has broken ground for a second such structure at Wood River, Ill., and plans call for the establishment of a permanent dome division to prefabricate and erect domes for other companies through its subsidiary, Graver Tank & Manufacturing Company, Inc. The Wood River facility will be the twenty-fourth shop in the United States and Canada. If progress continues at the same rate in the future, it will be difficult to estimate the number of such repair facilities that will be scattered through the western hemisphere by the end of the next decade.

# Air Isolation Protects Fragile Missile Parts

**E**ACH time a guided missile lifts off a launching pad or a rocket sled roars down its track, the terrific speed and acceleration produced form an awesome and exciting spectacle. Scientists looking on, however, devote little time to admiring the sights, because they are wondering if the equipment aboard the vehicles is going to function properly. One reason for their concern is that high speeds cause extremely severe shocks and acceleration loadings. Unless these jarrings are effectively muffled, they can easily disable components of the vehicles.

Walter Kidde & Company's Aviation Division, Belleville, N. J., has developed an air-operated system for protecting delicate equipment on fast-moving missiles. It bears the name "Pneumatic Vibration Isolation System," and is an arrangement in which air-operated cylinders neutralize forces caused by rapid changes in direction or speed. Other gases besides air can be used, too.

The basic device of the system is called an isolator. In a typical installation, three sets of isolators are placed between the equipment that is to be protected and the frame of the missile, plane or sled. One set per axis is installed for neutralizing forces acting in each of the three axes—two horizontal and one vertical. The greatest number of isolators are usually mounted on the axis receiving the heaviest shocks.

An isolator consists of three main parts: a housing, main shaft and servo valve. The housing is a metal cylinder about 20 inches long. Inside is the second part, the main shaft, that is attached at one end to the object being "isolated." The shaft moves freely inside the housing. The servo valve has two plungers: one controls the quantity of compressed gas or air admitted into the isolator; the other controls the amount of air exhausted to atmosphere.

When the missile accelerates, the mass being isolated will tend to shift against the direction of acceleration. As the main shaft moves with the body, the intake plunger is depressed and more pressurized air enters. This air acts against the end surface of the main shaft and forces the shaft—and the isolated mass to which it is attached—back to the original, neutral position. If the body overshoots as its position is being corrected, this motion actuates the exhaust plunger of the servo valve. Then,

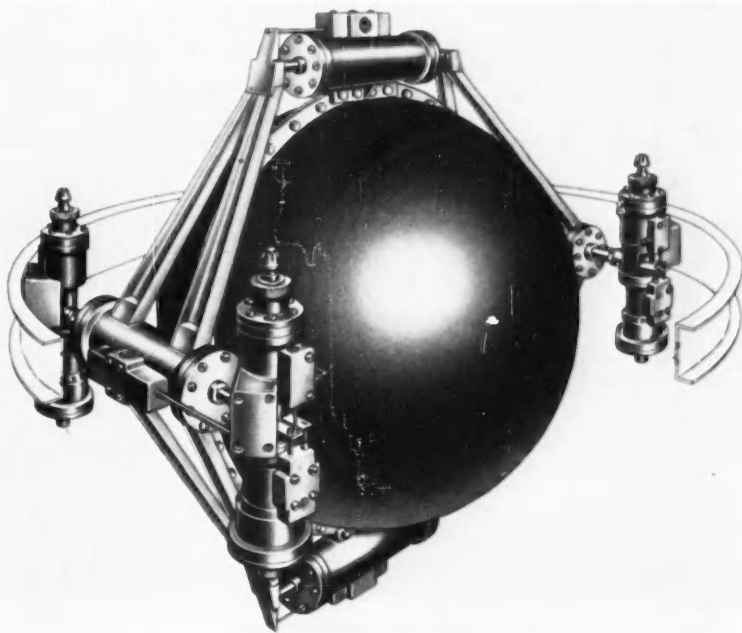
air is released until the correct location is found.

This system is designed for protecting delicate instruments, such as navigational and telemetering apparatus. The pressure at which the gas "springs" operate is determined by the missile's particular weight, dimensions and the like. Usually pressures used in the isolators are high; one rocket sled utilized 1200-psig air pressure, for example. The required gas or air is stored in tanks.

Kidde scientists and technicians don't know how much vibration or acceleration their units can absorb, because this is such a new field and each system is, essentially, tailor-made. They do know the isolators can withstand higher loads than were used on a recent rocket sled test. In this unit, loadings ranged from plus or minus 8 g's (8 times the normal force of gravity) at 7 cycles per second (cps) vibration, up to plus or minus 30 g's at 2000 cps. This vibration loading was made even more severe because of 0 to 10 g's of acceleration force.

For freedom of control, a closed loop servo-mechanism design is utilized—that is, one in which each step in a continuous system is dependent on the one preceding it. Designing such a system is no easy task because of this interdependence, and before an isolator unit is built, extensive analysis goes into its planning. The end product is a compromise of the spring characteristics for complete isolation, if the acceptable degrees of stability and positioning control are to be gained.

Servo valves used in the two lateral axes can be of two types, the choice depending on the accelerations that will be imposed along these axes. The valves can have a variable gas pressure on one side of the gas piston and a constant pressure on the other side. In other cases, both sides of the piston can have the gas pressure varied. All valves are affixed directly to the actuator housing, because this reduces delay in response and means the total pressurized volume is less than if longer lines were used.



## PROTECTING DELICATE EQUIPMENT

Typical installation of a Pneumatic Vibration Isolation System. The sphere in the center contains the delicate equipment being protected. Four isolators are used in the longitudinal axis to handle the heaviest shocks, and two isolators are mounted in each of the other two axes.

## This and That

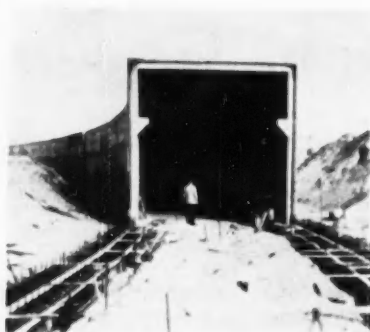
### High-Speed Information Center

Eastman Kodak Company has developed Minicard, an ultra-high-speed information handling system. It combines the advantages of microfilm, punched cards and digital computing techniques. Minicard can record documents, pictures or other information photographically on pieces of film about the size of a postage stamp. Each film record may include as many as twelve legal-sized documents at a reduction ratio of 60 to 1. Through the use of complex electronic controls, the Minicard system can be utilized to retrieve any desired information by searching the film records automatically at speeds as great as 1000 per minute. When the desired record has been obtained, its contents may be examined at full size on a reader. Duplicates, of either the record or the full-sized paper prints, may be made automatically.

\* \* \*

### Classroom Sales Training

A new field of career education will be instituted at Clarkson College of Technology, Potsdam, N. Y., next fall when students will begin training in marketing earthmoving, roadbuilding and other types of equipment that have revolutionized America's construction industry in recent years. Dr. William G. Van Note, Clarkson's president, announced the establishment of a curriculum in "Construction Equipment Distribution" that will lead to a degree of bachelor of science. Clarkson officials said that the



### PROTON RACEWAY

This is a cross-sectional view of the huge synchrotron shown on this month's cover. Inside this tunnel are being fitted 240 giant magnets that will serve to hold protons on course during acceleration to a speed approaching that of light. Each of the magnets has nearly identical properties. They were fabricated by laminating 0.031-inch thick steel 33x39 inches in dimension and of proper pole configuration. Two thicknesses were built up—75 and 90 inches. Because magnetic properties of steel vary not only from heat to heat, but sheet to sheet and even within sheets, great care had to be exercised to compensate for these irregularities. Fabricated by Baldwin-Lima-Hamilton Corporation, the steel for the magnets was furnished by Allegheny Ludlum Steel Corporation.

new curriculum has been set up in conjunction with the college's Department of Industrial Distribution which pioneered education in that field several years ago. The college will offer courses

dealing with the equipment itself, soils engineering, transportation and public service facilities, construction organization and, during the junior and senior years, civil engineering. Students will also have an opportunity to hear and consult with leaders in the construction equipment industry.

\* \* \*

### Compressed Air Heat Reduction

Niagara Blower Company has devised a new method of providing compressed air that is dried, cooled and cleaned for use with instruments or controls and for industrial or chemical processes where the presence of moisture or dirt from the atmosphere or lubricating oil is undesirable and damaging. The method, introduced at last month's Power Show in New York City, used two air machines in series: an Aero After Cooler and a compressed air chiller. In the first stage, the aftercooler receives the hot air from the compressor and reduces its temperature to approximately that of the atmosphere by evaporative cooling. The heat of compression is transferred to a stream of moving air by evaporating a water spray from the surface of the compressed air coils in the air stream. At this point, an oil separator removes the moisture and oil or dirt that have been condensed from the compressed air. In the second stage, the air chiller uses refrigeration to cool and further dry the air to meet exacting specifications. A recirculated water spray, in a closed system, is chilled by spraying over coils in which the refrigerant is expanded. The chilled spray then drenches the compressed air coil bringing the heat and moisture down to specifications. In a typical installation, the air produced at 45°F at 90-psig pressure, requires only 5 tons refrigeration for 900 cfm of free air. The air moisture will be only 0.065 pounds per 1000 cubic feet.

\* \* \*

### Batting Bulb Burn-Out

Electronic computers are being used for the first time in research to put more uniform life into electric light bulbs. The electronic units are being utilized to untangle the previously insurmountable maze of mathematical problems involved in the variances of light-bulb burn-outs. Experiments are being conducted at the Lamp Division of General Electric Company to determine why bulbs of identical quality or similar manufacture show great disparity in length of service life. Researchers say that the answer to this puzzle will lead to light-bill savings and



### SAFETY FOUNTAIN

Shown here is a water-fog curtain in a test operation at Boeing Airplane Company's Transport Division, Renton, Wash. It affords protection during fueling operations by preventing the spread of fire and heat between parked airplanes. There are five fueling positions at Renton field, and each is protected by its individual fog curtain. Each extends 155 feet and consists of 32 alternate wide- and narrow-angle spray nozzles. Water and spilled fuel flow into an underground drainage system.



fewer bulb replacements. A Bendix B-15 computer has been adapted to help solve radiation problems involving temperature changes in wire filaments and filament vibration, both important factors in lamp longevity. In conjunction with the projects, electronic computation also will be used in research programs for further investigation of new forms of light sources.

★ ★ ★

**Advance In Cryogenic Insulations** A series of super insulations, said to be 26 times more efficient than standard vacuum insulations and capable of holding liquid oxygen for indefinite periods, is now in use by Linde Company, Division of Union Carbide Corporation. The new insulations constitute a major breakthrough in the field of cryogenic engineering. Using them, liquid oxygen storage tanks can be built for missile stands that will hold the volatile liquid for months, and even years, with little loss. Liquid hydrogen and liquid helium storage containers that

need no liquid nitrogen coolant can also be constructed. Linde is now using the best of these super insulations in the construction of a large, unvented, liquid helium vessel. Fifteen-day pressure rise for the vessel will be below 180 psig. Although the insulations are ideally suited for such applications, they are also extremely useful for storing liquid hydrogen, oxygen and nitrogen. According to the company, a 26,000-gallon tank can be designed to have an evaporation rate of less than 2.6 percent of its capacity per year. A similarly designed tank for liquid hydrogen service will lose only 9 percent per year by evaporation.

★ ★ ★

**Power From Tides** A great source of power, relatively undeveloped by man thus far, is that of the rise and fall of ocean tides as the moon swings around the earth. Although cold and lifeless, the moon is so near the earth that its gravitational pull on the waters of the seas produces mechanical energy that is dissipated continuously in fric-

tion estimated at the rate of 2 billion hp. An optimum project arrangement for the use of tidal power as a source of energy at Passamaquoddy, between Maine and Canada, has been adopted after a \$3,300,000 engineering investigation. Recommendations to the Canadian and United States governments on the feasibility of the project will be made by the International Joint Commission from the conclusions of its Engineering and Fisheries boards. The project, which would generate electric power from the world's highest tides in the Bay of Fundy, would have a capacity of about 1.9 billion kw, using thirty 10,000-kw generators. Despite the fluctuating tidal movements, operation of the project would be continuous, with some capacity available at all times. It involves a 2-pool method of harnessing the tides. One pool, the high, will be constituted by 100 square miles of Passamaquoddy Bay, and the low pool, 38 square miles of Cobscook Bay. The powerhouse would be located at Carrington Cove. The project involves a 28,000-foot length of earth-and-rock-filled barriers, some to be 290 feet below sea level.

**When Man Goes To The Moon** Plans for a permanent "moon building" have been announced by the Wonder Building Corporation of America, one of the major manufacturers of pre-engineered metal structures in the United States. Work began shortly after the launching of the first Russian sputnik and is under the direction of Dr. John S. Rinehart, Professor of Mining Engineering and Director of the Mining Research Laboratory, Colorado School of Mines. (He was the former Associate Director of the Smithsonian Astrophysical Observatory, Cambridge, Mass.) From a scale model, it can be seen that the building will be 340 feet long, 160 feet wide and 65 feet high. Including an air lock and a plastic observation bubble, it will be 520 feet long. It has been designed for the worst possible condition anticipated—a sea of dust upon which the structure would have to float, anchored by heavy weights suspended by cables from the body of the structure. The moon building is cigar-shaped and is to be fabricated of corrugated aluminum alloys that combine great strength and low weight for ease of fabrication and transportation. Aluminum also provides a good reflecting surface to aid in the problem of cooling. Each piece of the unit can be no longer than the load-carrying capacity of future moon rockets. The sheets will be secured by simple nut-and-bolt fasteners and welded structural connections to permit quick erection with minimum labor and tools.

Entrance will be made through the



air lock. Complete internal pressurization of the hermetically sealed building is to provide an absolute air pressure of at least 10 psia—close to earth's normal atmospheric pressure and the same as that used in high-altitude airliners. Inside will be living quarters, including rooms for sleeping, cooking, eating and recreation; physics, chemistry and biological laboratories; a control tower for communications, meteorological studies, earth and astronomical observations, traffic control, and the like; air conditioning and heating plants to cope with lunar temperature ranges of 214°F at midday to a minus 243°F at midnight; power and refrigeration plants; oxygen-producing units; main-

tenance and machine shop areas; and water supply and sewage-processing plants.

There are no windows in the moon building, since ultraviolet radiation, normally absorbed by the earth's atmosphere, would be sufficiently intense to render panes of glass or plastic useless through discoloration. Metal shutters protect the plastic observation bubbles.

Above, and separated from, the roof of the building is a slightly curved umbrella-shaped protective meteor shield, designed to ward off the gnatlike rain of interplanetary meteoric dust that descends with great velocity on the barren surface of the moon. The shield will be 460 feet long and 380 feet wide.

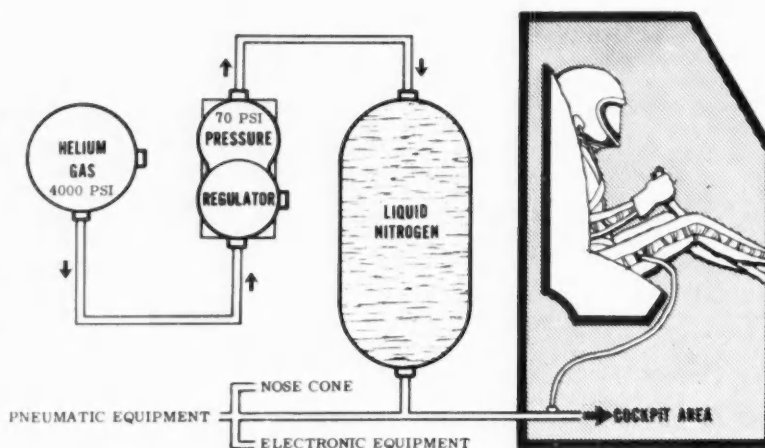
# X-15 Rocket To Carry Own Atmosphere

THE U.S. Air Force and the National Aeronautics & Space Administration have announced that when the high-powered X-15 space-craft zooms beyond the earth's air envelope, it will carry along its own atmosphere. This will be in the form of liquid nitrogen in an advanced pressurization and air conditioning system both for the pilot and vital equipment.

Produced by The Garrett Corporation's AiResearch Manufacturing Division, the nitrogen system is a radical departure from normal pressurization and cooling procedures which utilize outside air.

The change in system became necessary because the relatively dense air of ordinary altitudes is nonexistent in the environment for which the X-15 is designed. A self-contained supply thus must take over the jobs formerly done by pressurized air. Liquid nitrogen, at approximately minus 300°F, will do the job on the X-15 and will be used in vital areas to maintain adequate environmental pressure and also to act as a coolant.

Among the reasons for use of liquid nitrogen in the system, in addition to its refrigerant qualities, are its lack of fire or explosive characteristics, and the



relative ease of maintaining it in a liquid state.

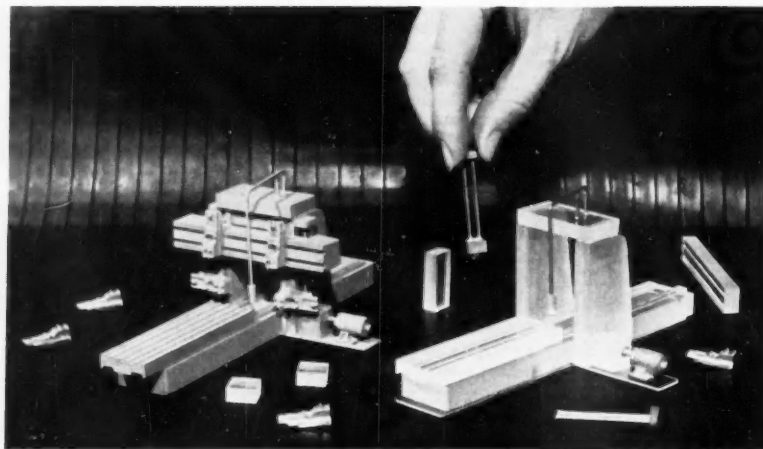
Applications include pressurizing and ventilating the cockpit and the pilot's flight suit, inside of which he breathes pure oxygen; cooling and pressurizing electronic equipment and providing an inert atmosphere for it; cooling the craft's nose cone; and operating pneumatic equipment. The nitrogen will be applied as fluid and as a spray, as well as being converted to the gaseous state.

Because of excessive acceleration loads likely to be imposed by the X-15, and because of changes in the vehicle's flight attitude, it is necessary to apply a positive transfer method to the nitrogen system, thereby assuring a constant flow to needed areas. Pressurized helium will be used for this task. Contained in a spherical chamber at 4000-psig pressure, the gas will be directed through a regulator and reduced to an operating pressure of 70 psig.

## 3-D Model Kit Helps Design Machine Tools

SOME years ago, a new way of life began. Appealing to young and old alike, it held a special attraction for executives who spend long hours at desks with paperwork as their main exercise. Since its inception, the do-it-yourself "fad" has brought forth new avocations and has been applied to almost all hobbies, including many that previously were not thought of as pastimes. The general movement from urban life to that in the suburbs has broadened the field almost beyond conception.

Recently, do-it-yourself has been applied to industry. A Swedish designer developed the FAC System of machine construction (COMPRESSED AIR MAGAZINE, May 1958); and now, Scott Industries, Inc., has announced the introduction of an assemble-it-yourself machine tool kit. It includes 3-dimensional mod-



els of planing mills, lathes, milling machines, drilling and sawing units, sheet metal machines and the like, as well as office equipment. All are accurately scaled to size. In addition, literally thousands of extra parts, such as pipe, fittings, motors, etc., are available to help solve plant layout problems.

Most plant engineers use 2-dimensional templates, knowing that by adding

the third dimension, costs would be increased disproportionately. With the Scott kit, plant personnel can quickly and easily do the final assembly and painting, according to Scott, thus representing a savings of as much as 50 percent of out-of-pocket costs previously involved. Beyond this, the kits produce, in the final analysis, a more effective, economical plant layout.

# EDITORIAL

## Petroleum



ENTENNIAL dates are usually based on a significant, but not necessarily the first, event in the development of an industry. Such is the case with the anniversary of petroleum being celebrated this year. It will be 100 years ago this August that Colonel Drake successfully completed the first producing oil well in this country and sparked an industry that has grown to phenomenal proportions. As to the actual use of petroleum, the Egyptians were probably the first to toy with the black fluid, and there are well documented applications dating several centuries before Christ.

In the next half century, there will be a number of other centennials (the horseless carriage's, for example) that will owe their very existence to the discovery of ways to extract petroleum from the earth's crust. Of all of the inventions and findings of the nineteenth century, however, none have had such far reaching effects as the well-drilling exploits of the ingenious Drake. Besides the fact that almost every piece of machinery in this country turns on a thin film of petroleum oil or grease, approximately 45 percent of energy fuel needs are met by oil or natural gas. This is an increase of almost 20 percent in just the last 15 years and represents a considerably larger percentage of growth in the actual volume of use. Since 1929, the demand for petroleum products has grown at a consistently faster pace than even the gross national product.

**O**BSERVANCE of one centennial leads most people to a thought of future ones. Estimates of the length of time that the reserves of crude oil will continue to grow faster than the stuff is taken from the ground vary from 10 years to several centuries. Mother Nature being as capricious as she is about revealing the secrets stored deep underground, it may be that either guess is correct. It is a certainty that eventually the oil supply will be exhausted. By that time, atomic energy it is said, will have taken over virtually all of the fuel energy needs of mankind. There are those who would say that synthetic lubricants will also have replaced oils and greases of petroleum derivation by that time and that the heyday of petroleum will pass. With the advent of cheap energy from the atom, petrochemicals will be manufactured from "scratch"—from the original hydrogen and carbon atoms—the prophets say.

If, on the one hand, it seems that man has nothing to fear from a shortage of petroleum, other forecasters predict a period of agonizing reappraisal of our energy needs when petroleum supplies give out. They indicate that coal will

become a highly-valued substitute and that oil shales of the least bitumen content will assiduously be sought and mined.

**T**HE BULK of industry experts, however, feel that the most accurate forecasts both of time and effects lie somewhere between these extremes. They foresee extensive conservation efforts and increasingly efficient extraction and refining methods. The period of transition from an oil-based machinery age to the one of the atom will be neither easy nor "agonizing." They point out that even now we are in this transitional state to the extent that conservation practices are becoming more widespread than ever before, that refining and treatment processes are gleaning more valuable products from a barrel of crude with each passing year. One way that this is illustrated is in the matter of costs. A given dollar amount of gasoline today, for example, when compared with gasolines of 20 years ago and with allowance made for inflated dollars, will carry a ton farther down the road. Even when taxes are included in the price of gasoline, its price has risen only a fraction of the total rise of such commodities as labor and even raw crude.

**G**REAT progress is being made in refining and extraction methods, there is no doubt. A good deal of the credit for these advances must be given to suppliers of the capital equipment used in such processes. The famed conservation program in Lake Maracaibo, Venezuela, for example, relies on centrifugal compressors to inject once-wasted natural gas back into the oil bearing sands. Although centrifugal machines working at the pressures involved had never before been built, a manufacturer came up with satisfactory equipment in an installation that has since been duplicated.

Catalytic cracking has been chiefly responsible for the advances in refinery output. The most modern installation of all—Tidewater's Delaware Refinery—makes use of the largest cat-cracker blower in the world. New pumps, handling materials of a corrosive nature at temperatures and pressures unheard of several years ago, are now commonplace. Compressed air has received a great deal of attention as a hole-cleaning medium in drilling the vast number of new wells necessary for discovery and production each year. (In 1957, more than 10,000 wells were drilled in the United States and Canada alone; almost that many were put down in 1958.) Whatever the future of petroleum may be, compressors, vacuum pumps and fluid pumps will be required and probably for conditions now unforeseen.

## SAVING WITH AIR POWER

### New Floors For Rail Cars

**F**LAT CARS of a western United States railroad that need new docking boards are moved to the railway's shops in Los Angeles, Calif., where new 3x8-inch planks are fitted. The boards are purchased as rough cut lumber and cut to the correct lengths just prior to their installation.

Formerly, the railroad was hauling the boards ¼ mile from the storage yard to the carpenter shop where they were measured and sawed. The sawing alone required three men working 1 hour. Then, the boards were loaded onto the truck again and carried about ⅛ mile to the repair track where they were unloaded. After being placed on the car, they were bored with an Ingersoll-Rand Size 22KW Wood Borer and fastened down with an Ingersoll-Rand Size 510 Impactool.

Though the actual installing, using the I-R air-powered tools, was speedy, much time was being spent in the sawing operation and in haulage of the boards from storage, to the carpenter shop and to the repair track. If the sawing could be completed on the rail car, then all the handling operations would be combined into the simple one



#### AIR SAW TRIMS FLAT CAR DOCKING

An Ingersoll-Rand Air Saw trims 3x8-inch docking boards that are being installed on a railway flat car. This 1-man sawing operation takes only 15 minutes, though formerly three men needed an hour to do it at the railway carpenter shop. The savings in sawing time is \$6.18 per car (three cars refitted per day), and still more time is recovered because much hauling and handling are eliminated.

of moving the timbers directly to the car. An Ingersoll-Rand pneumatic saw was put into use and the boards were trimmed in place on the cars needing re-fitting. The operation, which formerly demanded the time of three men, now only requires one man; and instead of an hour being used, only 15 minutes go into the project.

At the company's wage rate of \$2.25 per hour, approximately \$6 is saved on each car. Three cars are now handled each day, so the savings total \$18 in sawing time alone. Additional savings are realized in the time and labor costs involved in the wasted motion of moving boards to and from the carpenter shop, and in loading and unloading the lumber.

### Torque Wrench Solves—

### Tank-Fitters' Troubles

**A** COMPANY in Tennessee that manufactures glass-lined hot water heaters had a two-fold problem with the installation of two ¾-inch brass pipe nipples in the tops of the heater tanks. The method for installing these nipples manually with a pipe wrench was time-consuming and awkward because of the fittings' high location on the tanks. Turning the nipples to the correct torque depended on the worker's judgment, and the torque was difficult to determine because of the softness of the metal. Further, in the process of inserting the small brass fittings, both tanks and nipples were often damaged or defaced.

Both problems were solved when the pipe wrenches were discarded and an Ingersoll-Rand 38PMT Torque Control Angle Wrench with a special ¾-inch Kirkland Chuck was put to work. This

chuck grasps the body of the nipple when the air tool is turned on. When rotation halts, the chuck releases. Using the air wrench and the chuck, the nipples were turned down to the correct torque and the necessity of depending on operator "feel" for the right tightness was eliminated. Use of the new method also prevented damage to both the nipples and the tanks because the cumbersome pipe wrenches were no longer used.

In addition to improving quality of the work and eliminating damage, the tool also cuts the cost of the operation. Formerly, it had taken 4½ man-hours to install 250 nipples with pipe wrenches. With the air tool, the same number are affixed to the tanks in only 2 man-hours. At the labor rate of \$2.00 an hour, a saving of \$5.00 per day was made with the change from manual to air tools.



#### INSTALLING BRASS NIPPLES

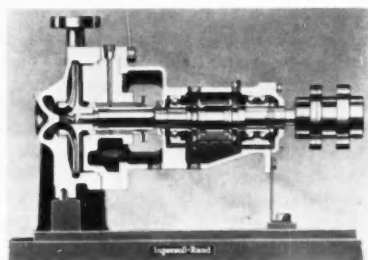
A workman uses an Ingersoll-Rand Size 38PMT Torque Control Angle Wrench to tighten brass nipples atop hot water heater tanks. The change to the air tool from pipe wrenches allows 250 of the brass fittings to be turned down in only 2 man-hours, as compared with the 4½ man-hours formerly needed. A ¾-inch Kirkland Chuck affixed to the I-R air-powered angle wrench helps eliminate damage to the nipples and tanks.





# Industrial Notes

**P**ROCESS PUMPS, designated Class SFLM, have been introduced by Ingersoll-Rand Company for heavy-duty, medium-temperature applications. The units are vertically split, single-suction machines with overhung impellers. Ca-



pacities to 1400 gallons per minute, heads to 650 feet and discharge diameters in sizes of 1 to 4 inches are available. According to the manufacturer, the pumps are ideal for a wide range of applications from subzero to 300°F where watercooling of the stuffing box and bearings is unnecessary. A special feature is said to be the pumps' versatile design that allows simple and inexpensive conversion to watercooled operation. All parts are interchangeable with the manufacturer's companion line of SFL watercooled units. The pumps, of sturdy construction, are described in a 6-page flier, Form 7494, that gives construction information, data on parts interchangeability and a detailed cross-section illustration. *Ingersoll-Rand Company, 11 Broadway, New York 4, N. Y.*

**P**NEUMATIC and hydraulic control panels can be fabricated using building blocks that have internal pressure, return and drain lines. The devices were developed because of the need of industrial designers to reduce external piping with simple components that may be combined to form varied system combinations. The panel blocks are extruded high-tensile aluminum that are stacked vertically in sequence as required by the circuit. Panels may rise as high as eight units, with an unlimited number of adjacent stacks. The components use leak-proof mounting-pad piping connections, and lines are drilled vertically, forming a continuous passage from block to

block, sealed by a counterbored O-ring at each connection. Tie rods are placed axially through these fluid passages with terminal fittings that either stop, or allow, fluid flow to the internal manifold. An 8-page bulletin (H-58) describes the fabrication technique. *Petch Manufacturing Company, 463 York, Detroit, Mich.*

**R**ECEIVERS are offered to purify and dry air to zero dewpoint and store it for use with instruments and for other applications in which clean air is mandatory. The unit, after purifying the air, delivers it clean and free of moisture. This prevents fouling, corroding and freezing of instruments, air tools, controls, circuits, finishes and chemicals. The compact, single-vessel receiver is said to require little space and a minimum of time for installation, maintenance and inspection. It operates without heat, regeneration or regulation.

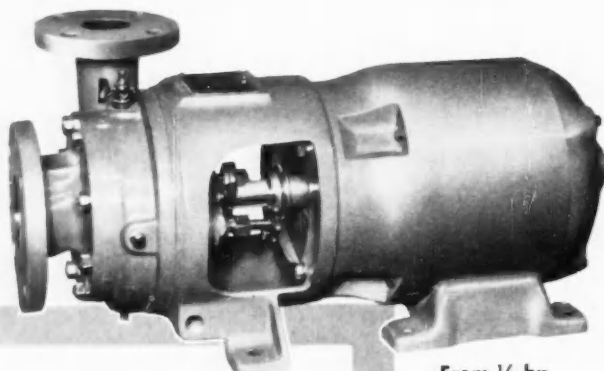
There is said to be no volume loss and less than a 1-percent pressure drop. Available models will hold to 8000 acfm at pressures as high as 6000 psig. The unit is described in the manufacturer's bulletin, D-R. *Van Products Company, 5729 Swanville Road, Erie, Pa.*

**M**OISTURE content of many materials can be determined with a moisture determination balance, Model 600. It is said that its accuracy of plus or minus 0.1 percent, and its swiftness of testing as compared with older methods, make this instrument valuable for laboratory or manufacturing control points. Determinations can be made on grains, cereals, flour, drugs, leather, paper, cement, milk, cream, paint, soil, etc. The unit is completely self-contained. It has a magnetically damped, analytical-type chain balance as its weighing system, and an infrared element that provides even heat to the sample in the heating



## EASILY INSTALLED AIR LINE

Flexible air duct, developed to carry hot and cold air in high- and low-velocity air conditioning systems, is shown here installed in the new Federal Reserve Bank in Chicago, Ill. Reportedly, the line is a time and labor saver. It bends without kinking and is easy to install around structural members and other obstructions in cramped quarters. It is available in lengths to 20 feet and inside diameters ranging from 3 to 12 inches, and is made of two materials—fabric and metal. The fabric, called Asbestos, is flame-resistant underwriters' grade asbestos cloth protected by laminated, polyester-reinforced aluminum foil. The metal is electro-galvanized steel spiral. The duct has a low friction loss, no odor and never needs painting. It is a product of the Wiremold Company, Hartford, Conn.



From ¼ hp  
to 75 hp

## ready now to solve your pumping problems

### Ingersoll-Rand **MOTORPUMP**

WHEN YOUR IMPORTANT PRODUCTION depends on proven pumping power, you need the efficiency and reliability of I-R Motorpumps! Low maintenance and minimum down-time mean cost-cutting operation that continues to pay off year after year.

I-R Motorpumps are always available in the widest range of types and sizes for every type of installation. Capacities from 5 to 2800 gallons per minute; heads to 650 feet.

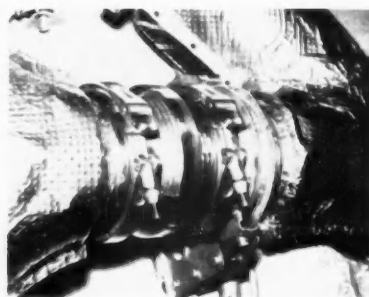
Compact Motorpumps are easy to install. They operate in any position, save valuable floor space. Write today for specifications and performance data.

**Ingersoll-Rand**  
9-827 11 Broadway, New York 4, N. Y.



chamber. In use, the sample is placed on a disposable aluminum foil pan, heated and dried. Then, by setting a dial, the amount of moisture can be read directly at any time during a preset time period. The output of the 650-w infrared heater can be controlled, and its distance from the sample can be adjusted from ⅛ to 1 ¾ inches. The pan is stable, enabling it to be used with liquids as well as solids. *Ohaus Scale Corporation, 1050 Commerce Avenue, Union, N. J.*

**HIGH-TEMPERATURE**, self-aligning air-duct joints are built for the aircraft, missile and related industries. The "Flexhot" joints illustrated have 10-degree self-aligning ability and 360 de-



grees of rotation. They are available with a 4-inch bore size and can withstand an operating pressure of 110 psig at 550°F. Other bore sizes are also available. *Southwest Products Company, 1705 South Mountain Avenue, Monrovia, Calif.*

**AIR MOTORS** are featured in a 16-page bulletin, Form 5072A, published by Ingersoll-Rand Company. More than 100 varieties that range from 0.3 to 24 hp, with speeds from 50 to 2580 rpm are listed. Both Multi-Vane and piston

motors are included with complete specifications and dimension drawings. Eight illustrated case histories show how the motors have saved time, money and man power in typical industrial applications. The design and construction features of the air motors are illustrated with cutaway photographs. Shown too, is a typical air motor power curve, and information on the ease and versatility of remote control operation of the units. Ingersoll-Rand Company, 11 Broadway, New York 4, N. Y.



**SOLENOID** valves are now being manufactured by C. A. Norgren Company, long a maker of air line filters, lubricators and regulators. The first



models are 2- and 3-way units designated as Series A and Series B. The "A" group is being furnished in 1/8- and 1/4-inch sizes, not only in the 2- and 3-way varieties, but in directional units as well. They are fabricated of stainless steel or brass, and each has a stainless steel seat insert. Either grommet- or conduit-type electrical outlets are available. Series B is a midget, 2-way, normally closed valve with 1/8-inch NPT ports. It has a



### **BROOK TOTALLY ENCLOSED, FAN COOLED, MOTOR DRIVES INCINERATOR DRAFT FAN.**

An ideal application for this 30 HP Brook Totally Enclosed, Fan Cooled, Slip Ring Motor—built to resist heat or cold, dust, fumes, moisture. It is driving an induced draft fan handling washed flue gas and raw air at 350°F. in an American Incinerator

Corp. system processing municipal waste. Brook A.C. Motors are winning praise in every industry for dependable service and overall economy. They can save for you! Warehouses, Sales Representatives, Dealers throughout the country. Send for literature.

*world's most respected motor*

## **BROOK MOTOR CORPORATION**

3553 W. Peterson Ave., Chicago 45, Illinois  
In Canada: BROOK ELECTRIC MOTORS OF CANADA, LTD.  
250 University Ave., Toronto, Ontario



## **ADAMS FACT FILE #2**

### **PLANT AIR**

#### **Moisture Chief Cause of Trouble...**

Every company today is looking for ways to offset the increased costs of labor, material, equipment and services. At a gasoline station you expect "Free Air", but in industry it is a major expense. Perhaps in your own plant, for an investment in a few minor compressed air system alterations, significant savings are possible.

Water, sludge, rust, oil and dirt in compressed air systems are prime causes of maintenance and production down-time. Water vapor condensing in air lines tends to corrode the piping. Also, water present in the piping may freeze during winter, causing serious reduction of compressed air supply. Such restrictions are often difficult to locate and thaw. This same line moisture may emulsify lube oil destroying its lubricating value and the resultant mixture has high fouling characteristics. Frequently, ice will form within the tool itself since expanding air cools the moisture... tool efficiency will be seriously affected.

#### **Some of the Other Problems Created By Wet Compressed Air...**

Wet compressed air is not only a construction and production tool problem. Faulty paint jobs, contaminated chemical and food products can often be traced to moisture laden compressed air. Water-hammer, unequal pipeline thermal expansion and line leaks also result from collected moisture. In addition, air lost through traps, and in blow-down of compressed air lines provide no useful work... represent a sizeable power loss.

#### **You Can Lick Compressed Air Moisture Problem...**

All of these hidden costs can be virtually eliminated by the installation of an Adams Aftercooler and Cyclone Separator between the compressor and receiver tank. By cooling discharge air to within 10° F. of cooling water temperature — guaranteed with Adams standard Aftercoolers — the moisture can be removed at the separator. Pressure loss is less than one-half pound on these units including the separator. In severe cases, moisture removal of over 90 per cent can be obtained by cooling the air with Adams 2° Aftercooler to within 2° F. of water temperature.

#### **Air Filter for Final Protection at Point of Use...**

As an added safeguard for expensive tools and equipment, an Adams Poro-Stone Air Filter should be installed just before the air is used. These filters remove all solid material picked up by the air stream. With an Adams Aftercooler, Cyclone Separator and Air Filters clean, dry, trouble-free air is supplied to your production tools. You get continuous service with minimum maintenance.

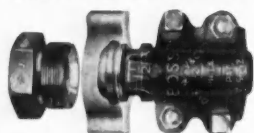
For further information on how the complete line of Adams air equipment can solve your compressed air problems, write today for your free copy of Bulletin No. 712 on Aftercoolers and Bulletin No. 117 on Poro-Stone Air Filters from the R. P. Adams Company, Inc., 209 East Park Drive, Buffalo 17, New York.

*For Those  
Heavy Duty  
Air Jobs...*



## "GJ-BOSS"

GROUND JOINT, STYLE X-34  
HOSE COUPLING



The female-type coupling you can rely on for tight, safe connections on the big drills; manifolds; jumbos; in caisson work; and all other high-pressure operations. Copper insert in spud fits rounded head of stem, forming soft-to-hard, leakproof metal seal. "Boss" Offset Interlocking Clamp provides powerful grip on the hose—proof against blow-offs. Also available in washer type, and with companion male coupling. Sizes  $\frac{1}{4}$ " to 6".



## "BOSS" HOSE MENDER STYLE BM-16

The practical, safe way to quickly restore damaged hose to service. Complete fitting consists of mender tube and two "Boss" Interlocking Clamps. Tube has flanges to engage clamp fingers. Tube shanks have well-defined, smooth corrugations. Thoroughly rustproofed. Sizes  $\frac{1}{2}$ " to 6".

Stocked by Manufacturers and Distributors  
of Industrial Rubber Products

**DIXON**  
Valve & Coupling Co.

GENERAL OFFICES & FACTORY—PHILADELPHIA 22, PA.  
BRANCHES—CHICAGO · BIRMINGHAM · LOS ANGELES · HOUSTON  
DIXON VALVE & COUPLING CO. LTD., TORONTO Associate Companies:  
Rock Iron Company, Inc., Quarryville, Pa. · Precision Brass Steel Company, Camden, N.J.

brass body with a stainless steel seat insert and grommet-type electrical outlet. Both models are designated for air, oils, cold and hot water, and gases. Operation to 600 cycles per minute is assured, and the units are said to have a service life expectancy of more than 30 million cycles. They are designed to operate at temperatures ranging from minus 20° to 200°F ambient and minus 20° to 175°F media. C. A. Norgren Company, 3400 S. Elati Street, Englewood, Colo.

**Q**UICK-COUPLED, all stainless steel piping systems can be fashioned with the aid of Schedule 5 and 10 roll-grooved stainless steel pipe fittings. The line of fittings is said to be the first in a series that will permit integrated quick-coupled systems in a wide range of materials. Stainless steel elbows, tees, crosses, returns, stub and blank ends, reducers and reducing tees, with roll-



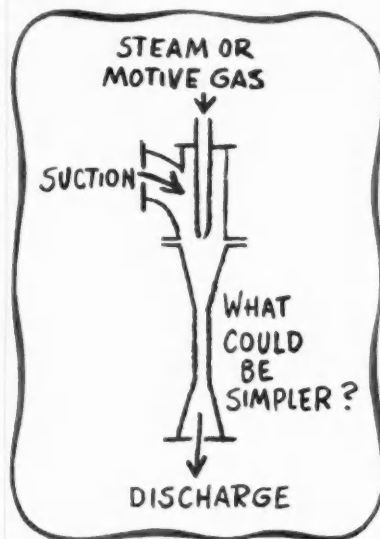
grooved ends, are available in sizes that range from 1  $\frac{1}{4}$  to 4 inches in diameter. The fittings are made from AISI Types 304 and 304L, austenitic 18-8 chromium-nickel alloy. They are also available in 316 and 316L alloy for systems with more severe temperatures and corrosive conditions. According to the manufacturer, the fittings reduce by half the cost of jointing Schedule 5 and 10 stainless steel piping when compared to welding or flanging. The availability of fittings in Schedule 5 will permit the use of this lightweight material for cases in which heavier Schedule 10 was used only for its welding properties and not its added strength. Victaulic Company of America, Elizabeth, N. J.

**M**OTORPUMPS of Ingersoll-Rand Company's "K" line are described in Form 70022, a recently published 8-page bulletin. These "off-the-shelf" items are available in twenty sizes ranging from

# how to move GASES

with

## NO MOVING PARTS



**In I-R Ejectors,  
nothing moves  
but the motive  
and suction gases**

**A**S SIMPLE and sturdy as a piece of pipe, the I-R Ejector offers real economy and dependability for a wide range of applications.

They can be used to create vacuum or increase pressure, and to mix gases.

Your nearest Ingersoll-Rand branch office or representative will be glad to give you complete information. — Or write today for a copy of Bulletin 9013-A.



**Ingersoll-Rand**  
11 Broadway, New York 4, N. Y.

4-659



1/3 through 25 hp, for heads to 190 feet and capacities to 775 gallons per minute. Selection charts, friction tables and a typical pump work sheet are included; tables give the dimensions of the pumps in the line, and some of the available modifications are listed. *Ingersoll-Rand Company, 11 Broadway, New York 4, N. Y.*

**CLAMPING** high-pressure hoses, flexible tubing, hydraulic fluid lines, water hoses, and lines to pneumatic equipment, can easily be accomplished with Circle Clamps. It is said that the clamping action is so secure that it will outlast the life of the hose or line it holds. A pair of ordinary pincers is all that is needed to make the joint. To remove the units, a simple snipping action is required. Circle Clamps are fabricated of SAE 1010 steel with a cyanide zinc, electroplated finish in sizes ranging from 1/4 to 2 5/8 inches, ID. *Eastman Atlantic Manufacturing Company, P.O. Box 25, Wilmington 99, Del.*

**VAPOR-FLO** Motorpumps for pumping petroleum have special impellers that are said to eliminate gas binding and loss of prime. They are discussed in Ingersoll-Rand Company's flier Form 70021. Centrifugal pumps are designed for flooded suction services where vortexing and vaporizing may develop. The impeller in each has only three vanes, and its passages diverge toward the periphery instead of converging. Thus, the liquid leaves the periphery faster than it enters the eye, and a partial vacuum

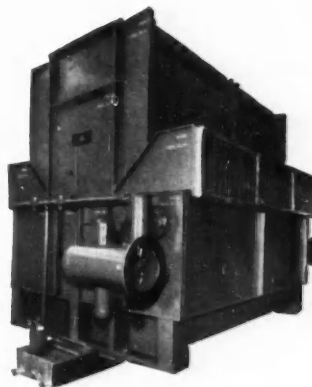


"In my 10 years as foreman, only one other man has made that mistake."

## ECONOMICAL COOLING OF GASES AND COMPRESSED AIR

Cooling gases or cooling and removing moisture from compressed air, the *Niagara Aero After Cooler* offers the most economical and trustworthy method. Cooling by evaporation in a closed system, it brings the gas or compressed air to a point below the ambient temperature, effectively preventing further condensation of moisture in the air lines. It is a self-contained system, independent of any large cooling water supply, solving the problems of water supply and disposal.

Cooling-water savings and power-cost savings in operation return your



equipment costs in less than two years. New sectional design reduces the first cost, saves you much money in freight, installation labor and upkeep. *Niagara Aero After Cooler* systems have proven most successful in large plant power and process installations and in air and gas liquefaction applications.

*Write for Descriptive Bulletin 130.*

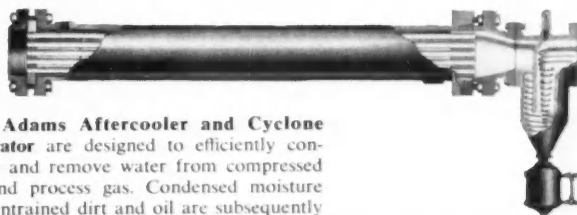
## NIAGARA BLOWER COMPANY

Dept. CA-1, 405 Lexington Ave., New York 17, N. Y.

*Niagara District Engineers in Principal Cities of U. S. and Canada*

## Aftercooler and Cyclone Separator designed for cleaner, dryer compressed air

R. P. ADAMS CO., INC.  
209 East Park Drive, Buffalo 17, New York



The *Adams Aftercooler and Cyclone Separator* are designed to efficiently condense and remove water from compressed air and process gas. Condensed moisture and entrained dirt and oil are subsequently removed in a cyclone type separator. This unit is scientifically designed for maximum removal efficiency over a wide range of flow rates.

For normal use, units are available to cool gases to within 10° F of the temperature of the cooling water. Specially designed units are available to permit a 2° F approach to cooling water temperature, for application where low moisture content is critical.

*Adams Aftercoolers and Separators* are available from stock to handle 20 - 40,000 cfm with 10° cooling and 25 - 19,200 cfm

where it is necessary to cool within 2° F of the cooling water. Special units can be supplied to suit an unlimited range of requirements. In all cases the maximum pressure loss at rated capacities is 1/2 psi.

This wide range of sizes enables the economical utilization of *Adams Aftercoolers and Separators* in virtually all industrial application. For further information on how R. P. Adams' units will solve your compressed air problems and save you money, write today for Bulletin 711.

# FOR LOWER TON-MILE COSTS



## Replace with **DEPENDABLE** **CONTINENTAL** RED SEAL **POWER**

In highway hauling, as elsewhere, profit margins continue to shrink, and wise choice of rolling stock becomes more essential than ever. That is why more and more truckers are replacing original equipment engines with rugged Continentals, engineered expressly for the job. Choose from the models listed below. See your distributor today.

### RED SEAL TRANSPORTATION ENGINES

#### GASOLINE

Model	Cyl.	Displ.	Bare Engine H.P.
N4062	4	62	26.3 @ 3500 RPM
Y4069	4	69	28.0 @ 3400 RPM
Y4091	4	91	36.0 @ 3400 RPM
F4124	4	124	47.0 @ 3200 RPM
F4140	4	140	52.0 @ 3200 RPM
F4162	4	162	58.0 @ 3200 RPM
F6186	6	186	77.0 @ 3500 RPM
F6209	6	209	90.0 @ 3500 RPM
F6226	6	226	98.8 @ 3500 RPM
F6244	6	244	103.3 @ 3500 RPM
M6271	6	271	96.5 @ 3000 RPM
M6290	6	290	108.0 @ 3000 RPM
M6330	6	330	125.0 @ 3000 RPM
M6363	6	363	146.0 @ 3000 RPM
B6371	6	371	123.5 @ 3000 RPM
B6427	6	427	142.0 @ 3000 RPM
F06226	6	226	126.2 @ 3400 RPM
K6271	6	271	114.5 @ 3200 RPM
K6290	6	290	123.0 @ 3200 RPM

Model	Cyl.	Displ.	Bare Engine H.P.
K6330	6	330	147.0 @ 3200 RPM
K6363	6	363	162.0 @ 3200 RPM
T6371	6	371	143.8 @ 3000 RPM
T6427	6	427	170.0 @ 3000 RPM
U6501	6	501	186.0 @ 2600 RPM
R6513	6	513	192.2 @ 2800 RPM
R6572	6	572	220.0 @ 2800 RPM
R6602	6	602	232.0 @ 2800 RPM
S6749	6	749	250.0 @ 2800 RPM
S6820	6	820	300.0 @ 2800 RPM
V8603	8	603	260.0 @ 3200 RPM

#### CUSHIONED POWER DIESEL

Model	Cyl.	Displ.	Bare Engine H.P.
TD6427	6	427	146.5 @ 2600 RPM
RD6572	6	572	172.0 @ 2400 RPM
VD8603	8	603	200.0 @ 2800 RPM
SD6802	6	802	225.0 @ 2200 RPM

PARTS AND SERVICE EVERYWHERE

**Continental Motors Corporation**

MUSKEGON • MICHIGAN

6 EAST 45TH ST., NEW YORK 17, NEW YORK • 3817 S. SANTA FE AVE., LOS ANGELES 58, CALIF.  
6218 CEDAR SPRINGS ROAD, DALLAS 9, TEXAS • 1252 OAKLEIGH DR., EAST POINT (ATLANTA) GA.



is formed. Any gases or vapors that may be present fill this vacuum and are conducted out of the pump without interfering with the liquid flow: this prevents clogging or the loss of prime. Vapor-flo Motorpumps are built in sizes ranging from 2 through 7½ hp; their discharge connections range from 1½ to 3 inches in diameter and are threaded. *Ingersoll-Rand Company, 11 Broadway, New York 4, N. Y.*

**SNAP-JACK** is a transparent acetate holder for mounting of individual micro-film images on a filing card. It is useful when the filmed document must be part of a card that contains other information, such as drawings, deeds, mortgages and manufacturing specifications. A filmed document can be removed from a roll of film and inserted into the Snap-Jack pocket, which in turn snaps into any type of filing card having a pre-cut aperture. Accommodating 16-, 35- and 70-mm film, the device's top and bottom edges fall into place on the same edges of an aperture in the card. The remaining area of the card provides space for written data. *Sperry Rand Corporation, Remington Rand Division, 315 Fourth Avenue, New York 10, N. Y.*

## Books . . .

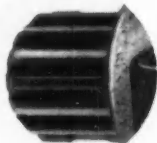
*Chemical Engineering Catalog* (Published by Reinhold Publishing Corporation, 430 Park Avenue, New York 22, N. Y.) comprehensively describes equipment supplies for the process industries. This 1959 edition is the forty-third to be issued and contains some 1800 pages listing products of several hundred manufacturers. As in the past, the catalogue contains these indexes: a Company Catalog Index, that alphabetically lists manufacturers with information in the catalogue; a Functional Index, that is a checklist for selecting the general type of equipment for a specific job; an Equipment and Materials of Construction Index, that lists manufacturers under product headings; an Engineering Services Index, that tells of companies offering engineering aid as well as equipment; and a Trade Names Index, which contains special words used by manufacturers. The bulk of the catalogue is composed of a section of product descriptions, the greater number being the manufacturers' own bulletins in color. They are alphabetized by company name. The volume is available free of charge to qualified persons in the chemical engineering and process fields in the United States and Canada. It may be obtained by writing, on company letterhead, to the publisher. Persons in other countries can purchase the catalogue. 1810 pages. Cost, \$30.

introducing  
the **ALL NEW**  
SIZE 834 **impactool...**  
1 1/4" capacity

**25% more power!**  
**6 3/4 inches shorter!**  
**7 pounds lighter!**

than the size 534

*optional features*



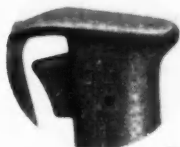
**Spline Drive Anvil**

For transmission of maximum power to the socket, many prefer the spline drive which is optional. The closer fit and greater driving area also provide increased socket life.



**Swivel Inlet Assembly**

Where extreme maneuverability is a problem, the optional swivel inlet assembly makes the hose easier to handle.



**Inside Trigger Handle**

Preferred by some operators, the optional inside trigger handle prevents the possibility of the operator's hand being caught when the tool is used in extremely close quarters.



**FREE!** New Form 5248—describes the Ingersoll-Rand 834 Impactool in detail. Contains photos, specifications and lists standard and optional equipment and accessories.

**WRITE TODAY! Ingersoll-Rand**

11 Broadway, New York 4, N. Y.



for faster run-down, easier operation  
and better maneuverability in tight spots . . .

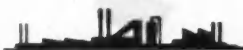
**MOTOR** Powerful new vane-type motor with direct drive to hammer provides greater torque and five times faster run-down. Motor housing is machined from a strong, lightweight alloy.

**IMPACT MECHANISM** New design operates at maximum efficiency to tighten the toughest nuts and bolts. Rated capacity, 1 1/4" thread size. No kick or twist is transmitted to the operator.

**THROTTLE VALVE** Graduated-action throttle valve permits quick homing of socket on nut. Rubber face provides positive seal; can be quickly and economically replaced when necessary.



Ingersoll-Rand



Tools plus AirEngineering  
increase output per man

**Complete information on pump  
design and application . . .  
NEW SECOND EDITION**

**By A. J. Stepanoff**  
**Development Engineer**  
**Ingersoll-Rand**  
**Company**



## **CENTRIFUGAL and AXIAL FLOW PUMPS**

### **Keeps pace with progress . . .**

This new edition has been revised and expanded to reflect the significant advances in recent years in the field of centrifugal pumps. During this period the application of such pumps has been extended to many new fields, while the ranges of head per stage, total pressure, temperature, speed, and size have moved to new high levels. Great progress has also been achieved in the theoretical aspects and design procedure based on a better understanding of the flow processes through the parts comprising a centrifugal pump. This book provides the modern treatment needed in view of these important developments.

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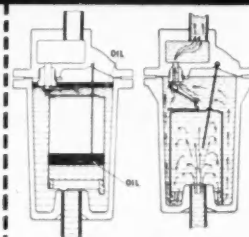
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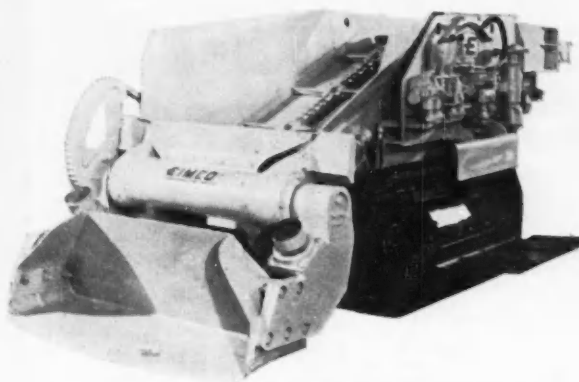
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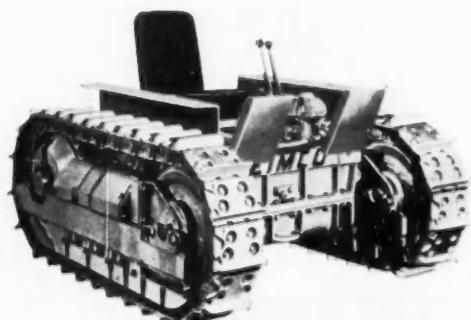


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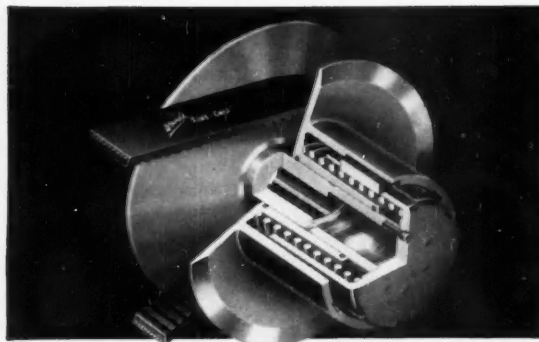
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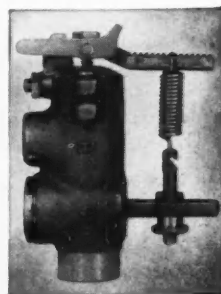
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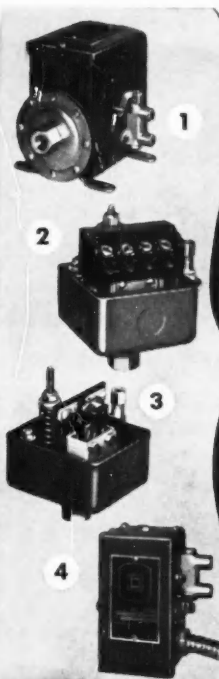
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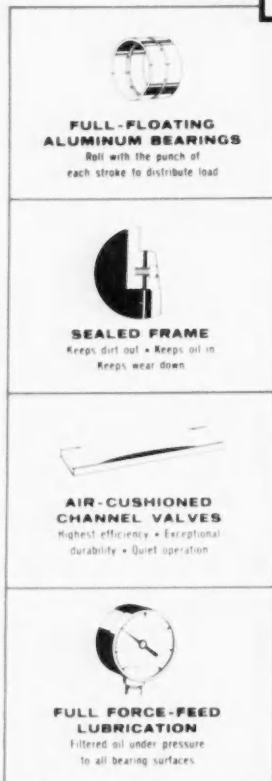
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